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ARCHIVES OF OTOLARYNGOLOGY

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TUBERCULOSIS OF THE LARYNX REQUIRING TRACHEOTOMY

M. C. MYERSON, M.D.

NEW YORK

It is important that the physician who has patients with tuberculosis of the larynx should know that something can be done for the condition. It is unfortunate that with all the advancement in the knowledge of the larynx and its diseases an erroneous impression exists that this complication of pulmonary tuberculosis is incurable and that the patient afflicted with it is doomed. The experience of Levy,[1] Thomson,[2] Lockard,[3] Greene,[4] Wood,[5] Lukens,[6] Spencer,[7] Dennis,[8] Wilson,[9] Dworetzky,[10] Wilkinson [11] and many others has proved that the contrary is true. Many persons in whose larynges the disease has been arrested are today pur-

From the otolaryngologic service, the Sea View Hospital.

Read before the Section on Laryngology, Otology and Rhinology at the Eighty-Sixth Annual Session of the American Medical Association, Atlantic City, N. J., June 14, 1935.

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10. Dworetzky, J. P.: Laryngeal Tuberculosis: A Three Years' Study, Tuberculosis Monogr. 2, Department of Health, City of New York, 1916.

11. Wilkinson, Richard W.: Laryngeal Tuberculosis, Arch. Otolaryng. **16**:331 (Sept.) 1932.

suing a normal existence. Only when the pulmonary disease is acute and active am I willing to admit that disease of the larynx cannot be arrested. When, however, the pulmonary condition shows a tendency to subside and heal, one can expect the larynx to do the same. This is especially true when the larynx is properly observed and treated by a competent laryngologist. One can except to change an actively tuberculous condition of the larynx into an inactive or healed one in from 15 to 25 per cent of cases. Certain it is that one can keep a majority of these patients comfortable. There was a time not long ago when the patient with laryngeal involvement was told to take care of the pulmonary condition and let his larynx take care of itself. Great progress has been made in the management of laryngeal tuberculosis; active and energetic attention to the laryngeal condition has replaced the attitude of former days.

This paper deals with a series of cases in which a tuberculous process affected the laryngeal airway so that a tracheotomy was required. These cases serve to disprove certain impressions which appear to be almost universally accepted. The tradition is that any patient who requires a tracheotomy because of tuberculosis of the larynx is marked for an early death. It cannot be denied that this is true in many instances. The fact is, however, that in a majority of the cases in which death occurs after tracheotomy there is involvement of other organs besides the lungs and larynx. The patient is suffering from the effects of an active dissemination of the disease which he is unable to resist. When the disease is not widespread and shows a tendency to become inactive in the lungs, the prognosis is different. The impression that all patients with laryngeal complications must have serious and extensive pulmonary disease is not justified by experience. These erroneous impressions frequently influence the decision against the performance of a tracheotomy, which if done would prolong life in many instances. Many patients can be benefited indefinitely or for a considerable period of time. For the patient who is seriously ill tracheotomy when indicated affords relief from unnecessary suffering during the last remaining days or weeks.

Histopathologic studies of the tuberculous larynx have been carried out with Dr. Auerbach, pathologist of the hospital, and will be reported at length elsewhere. I have classified the changes in the tissues of the larynx under two main headings: productive and destructive. Productive changes are a prominent feature of every tuberculous process. This is readily seen in the larynx. I have been impressed with the widespread hyperplasia of the mucosa and the cellular infiltration of the submucosal, perichondrial and muscular structures. Even when ulceration is the prominent microscopic characteristic, it is to be noted that the ulceration rests on an infiltrated base.

The lesions of the productive type are responsible for laryngeal obstruction. In a majority of cases productive changes involve the crico-arytenoid joint, so as to cause fixation of the vocal cord in or near the midline. In 6 of the 9 cases in which tracheotomy was performed in this series, the operation was required because of this type of lesion. In other cases obstruction of greater or less degree is caused by newly formed tissue which is laid down as tuberculoma, papilloma, pachyderma, polypoid tissue or submucous infiltration. Such a process may originate in the interarytenoid space, in the subglottic region or along the vocal cords, the ventricular bands and the ventricles. Perichondritis of the arytenoid cartilage is the most frequent lesion of the cartilages. It is by extension of the infiltration involving the perichondrium into the crico-arytenoid joint that ankylosis is caused, which fixes the cord. Occasionally, perichondritis of the cricoid cartilage, with or without necrosis, may extend to involve one or both of the joints. One of my patients had perichondritis with some necrosis of the posterior external wall of the cricoid cartilage, which caused complete fixation of both the crico-arytenoid joints. When the inner layer of the perichondrium and surface of the cricoid cartilage are involved, tumefaction of the subglottic region results, which is capable of causing serious obstruction. Perichondritis of the inner aspect of the thyroid cartilage causes tumefaction of the structure of the lateral fold of the larynx which includes the ventricular band, the ventricle and the vocal cord. When an abscess forms because of necrosis of the cartilage, the tumefaction is replaced by a large fluctuant mass which fills the corresponding side of the larynx, extending downward into the glottis and encroaching on the pyriform fossa. In case 1 of this series there was such an abscess.

More than fifty years ago Moritz Schmidt advocated tracheotomy to set the larynx at rest. Robinson [12] supported Schmidt's suggestion in this country. Schmidt claimed that tracheotomy favored subsidence of the swelling of the tissues, that the narrowed passages were replaced by a more adequate airway and that the larynx was rested. It is known today that the function of the larynx is such that tracheotomy does not afford complete rest, yet one is impressed with the marked improvement in the condition in the larynx which is frequently seen after tracheotomy is performed. Unfortunately there has been little experience with tracheotomy as an elective procedure to serve as a guide. For this reason the suggestion of Schmidt did not find ready acceptance. Perhaps another and even stronger reason is that laryngologists are reluctant to suggest the operation unless they are certain of accomplishing something for their patients.

12. Robinson, Beverly: Ulcerative Phthisical Laryngitis: Its Nature and the Value of Tracheotomy in Its Treatment, Am. J. M. Sc. **77**:407 (April) 1879.

One objection to tracheotomy has been that it hinders the removal of mucus and exudate from the trachea and bronchi. Although this is true in some cases, it is a fact that tracheotomy favors better expulsion in others. This depends on the type of pulmonary disease, the amount of exudate that is being formed and the strength of the patient's expulsive effort. When serious and active disease exists in the lungs, it is likely that the quantity of sputum will be too great and the patient will be too weak for easy and ready expulsion. On the other hand, when the patient is not debilitated and the exudate is not copious, expulsion by way of the tracheotomy tube does not present a problem.

The impression that all tracheotomy wounds in tuberculous persons become infected with the specific organism is unfounded. The wounds are likely to become infected in those cases in which a large amount of exudate carrying tubercle bacilli is coming up through the trachea and making contact with the tissues holding the tube. When there is comparatively little exudate, even though tubercle bacilli are present, the prospects of having a clean wound are very good. Of 11 patients with pulmonary tuberculosis who were subjected to tracheotomy, 3 had infection of the wound. Of those who did not have an infected wound 5 had sputum that yielded tubercle bacilli.

It is needless to state that tracheotomy should not be performed if the cause of obstruction can be eliminated by endolaryngeal instrumentation. The removal of obstructing tuberculomas or papillomatous masses can be accomplished by this means. Edematous swellings may be reduced by means of electrocautery. I prefer to use instruments in the tuberculous larynx by means of the indirect method (using a laryngeal mirror) instead of by the direct method, in which the speculum frequently causes undue pressure on the epiglottis. I have observed that the direct method is not used without harm, having noted ulceration of the epiglottis follow shortly on direct laryngoscopic examination.

When the larynx is obstructed by a tuberculous lesion and endolaryngeal methods are of no avail in relieving the obstruction, tracheotomy must be resorted to. According to Trousseau and Belloc, who wrote a classic treatise on tracheotomy in 1837, Hippocrates was the first to suggest intubation of the larynx in cases of obstruction. This method was revived by Desault but has not been accepted because it makes the patient very uncomfortable and can be used for only a short time.

Involvement of the larynx complicating pulmonary tuberculosis has been said by various authors to occur in from 8 to 40 per cent of cases. During the years 1932, 1933 and 1934, 6,516 patients with pulmonary tuberculosis were admitted to the hospital. Of these, 728, or 11 per cent, had some form of laryngeal involvement. Of these, 9 patients required tracheotomy for tuberculous involvement of the larynx, while 2 required

tracheotomy for nontuberculous involvement. One of the latter 2 may have had a tuberculous basis for the laryngeal picture, which simulated that of bilateral paralysis of the abductor muscle, while the other had carcinoma. Occasionally patients are seen with partial obstruction of the laryngeal airway; these patients are usually able to adjust themselves to the narrowed passage and do not require surgical intervention, but they must be watched, especially when there is infiltration of the arytenoid cartilages. This is important because fixation of the cricoarytenoid joint may develop at any time, which is sufficient to cause serious dyspnea.

Obstructive laryngeal dyspnea requires tracheotomy, and this should be performed before the obstruction becomes so pronounced as to endanger the life of the patient. Trousseau and Belloc [13] wrote a classic description of what happens to a patient with stenosis of the larynx:

> Fits of asthma at first occur during the night. Respiration is particularly difficult on exertion. Paroxysms of dyspnea become more severe and more frequent until death occurs from suffocation. The patients who have suffered from mere panting begin to experience what they call fits of asthma. At first this occurs in the latter part of the night; sometimes they are wakened four or five nights successively by paroxysms which increase in force. During the day they are better but have an unusual difficulty of respiration, especially when they take violent exercise or ascend a stair.
>
> After a while they cannot lie in bed but remain seated and propped up with pillows. They have similar attacks during the day; from this time the inspiration is hissing and the respiration is prolonged and braying. In a few days such violent paroxysms come on that the sense of impending suffocation causes the patient the deepest anxiety; the fits pass off, leaving continued orthopnea. More violent and more frequent paroxysms follow, until the patient finally dies of suffocation.

REPORT OF CASE

CASE 1.—*April 1932, tracheotomy; October 1932, tuberculoma of larynx; February 1933, necrosis of thyroid cartilage causing abscess; abscess evacuated; deformity of larynx due to healing; May 1934, tracheal tube removed; patient well.*

Z. C., a woman aged 28, was admitted to the hospital in February 1933 with a history of having had an emergency tracheotomy at the Bellevue Hospital in April 1932. This was performed by Dr. Imperatori after increasing laryngeal dyspnea of three weeks' duration. Six months later a tumor was removed from her larynx which proved to be tuberculous. The tube was removed at this time, but two months later it became necessary to insert it again. At the time of admission to the hospital roentgen examination of the chest and physical examination revealed a coalescent exudative lesion of the base of the right lung, with some involvement of the central portion of the left lung. Examination of the sputum gave negative results.

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13. Trousseau, A., and Belloc, H.: Traité pratique de la phthisie laryngée de la laryngite chronique et des maladies de la voix, Paris, J. B. Baillière et fils, 1837.

The larynx presented the following picture: There was a large ovoid mass which included the right arytenoid cartilage and aryepiglottic fold and encroached on the glottis, so that only the posterior half of the left vocal cord could be seen. The cartilage of the left arytenoid area was swollen. The mass was fluctuant and when incised yielded more than a teaspoonful of yellowish purulent fluid. This area drained for about two weeks.

In September 1933, a large granuloma formed, which originated from the upper lip of the tracheotomy opening and completely filled the trachea (above the tracheal tube). This was removed. The larynx was now well healed and presented a distorted lumen as a result of encroachment of the lateral internal wall on the glottis. The right vocal cord was fixed in the midline. A web of small size was to be noted in the subglottic region of the anterior commissure. In addition, the right arytenoid cartilage was almost entirely absent, and the left lateral wall was pulled inward by the healing. This was undoubtedly necrosis of the thyroid cartilage with the formation of an abscess.

Fig. 1 (case 1).—The left lateral wall of the larynx is pulled inward by the healing after the evacuation of an abscess in this region. There are fixation of the right vocal cord, partial fixation of the left cord and a small web in the region of the anterior commissure.

In May 1934 examination revealed a sufficient airway when the tracheal opening was occluded. The tracheal tube was withdrawn, and the tracheocutaneous fistula has persisted until the time of writing this report. No attempt was made to close the opening, because the additional airway was of value, as some degree of stenosis persisted. In May 1935 the larynx was healed and its function was as good as it probably will be.

Comment.—This patient displayed a tendency toward the formation of fibrous tissue, as was evidenced by the formation of a tuberculoma of the larynx in 1932 and a tuberculoma of the upper edge of the tracheal opening one year later. There was no tuberculous ulceration of the tracheal wound. More than three years after tracheotomy the patient is at home and is well.

CASE 2.—*Caseous tuberculosis of lungs; ulceration and infiltration of glottic region requiring tracheotomy; involvement of intestines and tubes; gradual downhill course; infection of wound; death.*

J. N., a woman aged 30, was admitted to the hospital on Feb. 16, 1933, with a history of pulmonary disease since 1921. Examination at the time of admission to the hospital revealed extensive caseous lesions involving the upper lobes of both lungs. The sputum was copious and contained many tubercle bacilli. The larynx presented edema of the regions of both arytenoid cartilages, with a piling up of interarytenoid tissue of a pachydermatous nature. Tracheotomy became necessary in May because of progressive laryngeal dyspnea caused by extensive swelling and ulceration of the vocal cords and the subglottic region. Prior to the time of the operation the temperature had fluctuated between 98 and 100 F.; from the time of operation until death three months later the temperature fluctuated between 98 and 103 F. A sinus developed below the tracheal wound, and later a large ulcerative lesion formed there. About two weeks before death the larynx

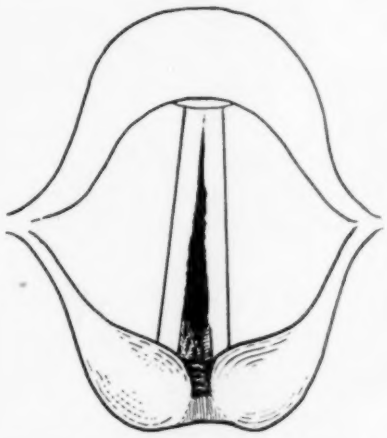

Fig. 2 (case 2).—Edema of both arytenoid cartilages, subglottic swelling and ulceration, swelling of both vocal cords and a large interarytenoid mass.

showed extensive fine ulcerations throughout. The course was progressively downhill from the time of admission to the hospital. The patient also suffered from intestinal tuberculosis and tuberculous salpingitis.

CASE 3.—*Exudative and productive lesions of upper lobes of both lungs; fixation of both cords; tracheotomy; improvement despite ileocecal involvement.*

R. M., a woman aged 31, was admitted to the hospital in June 1931. She had had pulmonary tuberculosis since 1927. She presented a moderately advanced lesion of the upper lobes of both lungs, with marked cavitation on the right side. The sputum had been positive at all times. Hoarseness was first noted in 1927. In April 1932 the patient complained of dyspnea; the interarytenoid space was narrowed by scar tissue. This was split and cauterized.

When the patient was first seen by me, in August 1932, there was stenosis which simulated that caused by paralysis of the abductor muscle bilaterally and which was thought to be due to involvement of both crico-arytenoid joints. The exact reason for this was not clear. Tracheotomy was performed in

November 1932, because of dyspnea. Several days after tracheotomy a large oval swelling appeared in the midline of the posterior external wall of the larynx, originating from the cricoid cartilage and extending upward toward the arytenoid cartilage on each side. The postoperative course was good. Incision of the mass behind the larynx yielded no fluid. In June 1933 some motion of the right cord was present, but the glottic space was inadequate. The condition of the larynx remained the same until the time of writing. There has been no infection of the tracheal wound, and the patient is comfortable and well as far as the larynx is concerned.

Comment.—Two and one-half years after tracheotomy this patient is alive and comfortable as far as the larynx is concerned. She presented an unusual cause of bilateral fixation of the vocal cords. Her condition was good despite moderately advanced pulmonary disease and the presence of ileocecal tuberculosis.

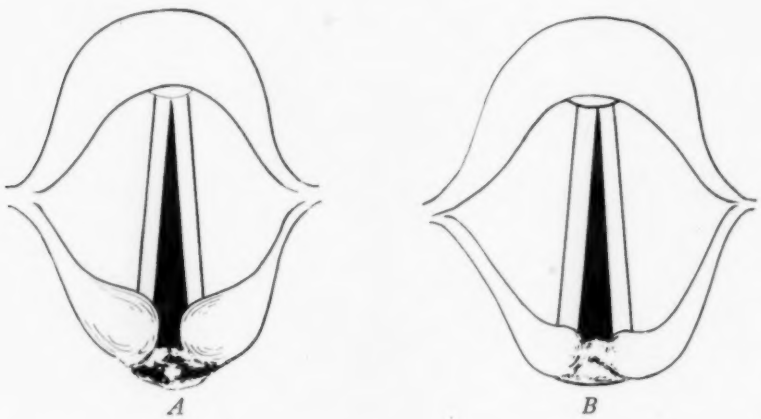

Fig. 3 (case 3).—*A* shows swelling on the posterior aspect of the cricoid cartilage, causing fixation of the vocal cords. *B* is the same view as *A*, after healing. The cords are still fixed.

CASE 4.—*Extensive tuberculous disease of several organs; fixation of vocal cords by involvement of arytenoid cartilages; tracheotomy; death one month later.*

T. V., a Negress aged 27, was admitted to the hospital on May 1, 1934. She had extensive bilateral caseous pulmonary disease of six months' duration. The sputum was strongly positive. The laryngeal involvement began three months before the patient was admitted to the hospital, at which time examination revealed marked edema of both arytenoid cartilages. There was a papillomatous proliferation in the interarytenoid space, and both vocal cords were ulcerated, thickened and injected. On May 13 there developed signs of serious dyspnea, so that a tracheotomy had to be performed. The vocal cords were now fixed in the midline. Four days after the operation the edge of the wound began to slough and a foul discharge was noted. The patient grew progressively worse and died on June 11, about one month after tracheotomy.

Autopsy revealed chronic ulcerative pulmonary tuberculosis, miliary foci in the right kidney, involvement of the ileocecal and mesenteric lymph nodes and ulceration of the hypopharynx.

CASE 5.—*Extensive tuberculous involvement of several organs; extensive ulceration and thickening of laryngeal structures; tracheotomy; death.*

A. P., a man aged 36, was admitted to the hospital on March 21, 1933. The pulmonary disease developed three years previously. There was a caseous pneu-

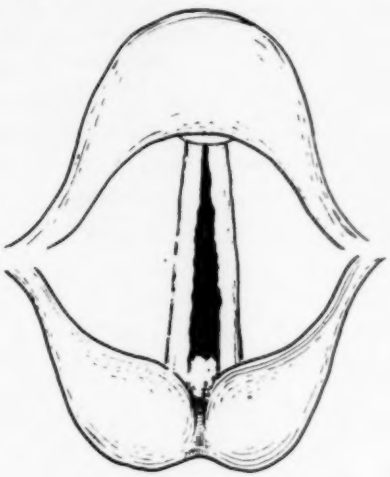

Fig. 4 (case 4).—Swelling of both arytenoid cartilages, fixation of the swollen and ulcerated vocal cords and proliferation of the interarytenoid spaces.

Fig. 5 (case 5).—Extensive ulceration and swelling of the vocal cords, ventricular bands and arytenoid cartilages, with extension of the disease into the subglottic region; thickening of the interarytenoid spaces.

monic process of the right side, with cavitation involving almost the entire upper lobe of the right lung. A cavity was present in the apex of the left lung. The larynx became involved in July 1932, with infiltration of the vocal cord and the ventricular bands.

In May obstructive dyspnea was present, due to extensive ulceration of the glottic structures, with considerable subglottic swelling and hyperplasia of the interarytenoid spaces. The tracheotomy wound healed satisfactorily. The course was progressively down-hill, and the patient died in September, four months after operation.

Autopsy revealed extensive caseous lesions of the upper lobes of both lungs and ulcers in the lower part of the ileum, the cecum, the ascending colon, the urinary bladder and the prostate.

Comment.—In this case there was no tuberculous infection of the tracheotomy wound despite the presence of an extensive and active disease in the lungs. In this type of case the larynx does not react well because of the type of pulmonary involvement.

CASE 6.—*Extensive pulmonary disease; fixation of vocal cords; tracheotomy; death.*

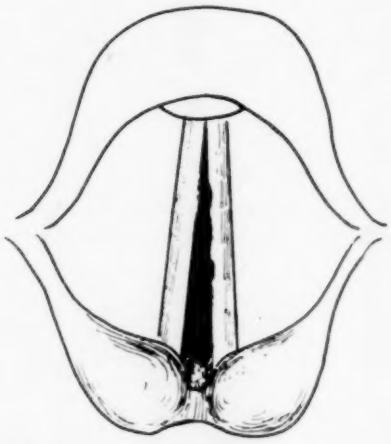

Fig. 6 (case 6).—Swelling and fixation of both vocal cords, with ulceration of the left cord and thickened interarytenoid space, with fixation less marked on the right side.

N. L., a man aged 25, was admitted to the hospital on Sept. 12, 1932. The pulmonary disease appeared in February of the same year. Four months later the larynx became involved. The upper lobes of both lungs contained several moderate-sized cavities. There were secondary diffuse exudative lesions throughout both lungs. The sputum was positive. On admission to the hospital the interarytenoid space was thickened and uneven, the vocal cords and ventricular bands were infiltrated, and there was ulceration of the left cord. An ulcer was present in the oropharynx. On April 18 marked dyspnea due to complete fixation of the left cord and partial fixation of the right cord necessitated tracheotomy. After tracheotomy extensive emphysema developed in the soft tissues of both sides of the neck. The patient died two days later of general debility and cardiac failure. Autopsy was not permitted.

CASE 7.—*Extensive pulmonary disease; fixation of vocal cords; tracheotomy; death.*

J. F., a man aged 22, was admitted to the hospital on Aug. 17, 1933. The pulmonary condition dated from 1930. There were extensive caseous changes of the left lung and diffuse exudative and productive lesions of the other lung. The larynx became involved in March 1933. Examination revealed reddened and edematous arytenoid cartilages and swollen and irregular cords. On August 31 the patient became dyspneic because of a marked decrease in the breathing space due to infiltration of the ventricular bands and immobility of the vocal cords. Tracheotomy was performed the next day. The wound healed satisfactorily, but the course was rapidly down-hill, and the patient died on November 19.

Autopsy revealed chronic bilateral involvement of the lungs and ulceration of the ileum, cecum and ascending colon.

CASE 8.—*Caseous tuberculosis of lungs; subglottic laryngeal involvement; tracheotomy; infection of the wound; death.*

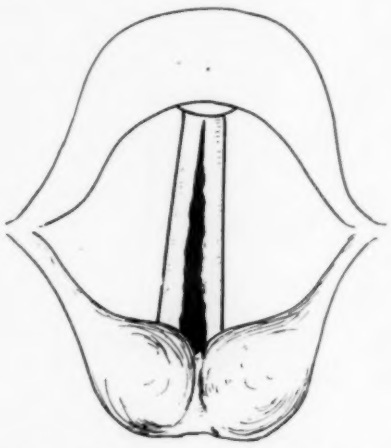

Fig. 7 (case 7).—Marked swelling and edema of the arytenoid cartilages and fixation, swelling and irregularity of the vocal cords.

P. S., a woman aged 29, was referred to me on Aug. 7, 1931. She had extensive tuberculosis of the upper and middle lobes of the right lung and some involvement of the upper lobe of the left lung. The pulmonary disease had been present for three years. Examination of the larynx revealed marked subglottic swelling. Because of the obstruction to breathing tracheotomy was performed at the Mount Sinai Hospital. The wound became the site of a tuberculous infection and healed slowly. Four weeks later the patient was transferred to a hospital for tuberculous patients, where examination revealed a good airway with some infiltration of the right ventricular band. The air passage was apparently adequate, indicating that the subglottic swelling had disappeared. The patient had been receiving pneumothorax therapy for some time. The course in the hospital was apparently uneventful until September 25, when she complained of difficulty in "expectoration." There was no obstruction to breathing. Respiration became labored, and cyanosis was present. Aspiration through the tracheal tube indicated a clear tracheobronchial passage. The patient died several hours later. The cause of

death was not explained. My impression is that the respiratory embarrassment may have been due to an accumulation of inspissated mucus in the lower portion of the trachea. Unfortunately, the organization of the hospital at that time, like that of so many such institutions, did not provide the personnel necessary to care for this type of patient properly.

CASE 9.—*Productive pulmonary disease; fixation of vocal cords; tracheotomy; condition improved.*

S. R., a man aged 29, was admitted to the hospital in December 1932. He presented diffuse exudative and productive lesions in the upper lobe of each lung. The pulmonary disease had developed in 1929, and the larynx became involved in November 1932.

Examination of the larynx in April 1933 revealed edematous swelling of the left side of the epiglottis. Both arytenoid cartilages were markedly swollen, especially the left. Both ventricular bands were swollen and presented slight

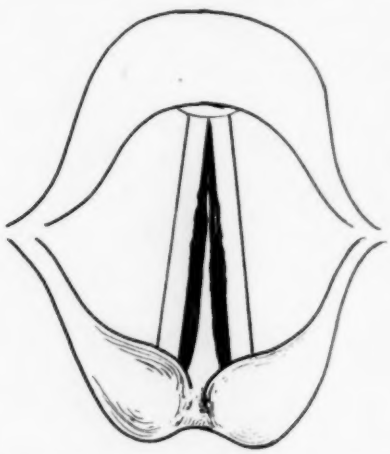

Fig. 8 (case 8).—Subglottic swelling and marked involvement of both arytenoid cartilages.

ulcerations. Cauterization of the epiglottis and arytenoid areas was carried out, with only slight improvement of the air space.

On August 24 examination revealed a small glottic space due to fixation of the crico-arytenoid joint on the left side and some limitation of motion of the joint on the right side. Four days later the patient consented to have a tracheotomy. The tracheotomy wound healed without infection. On November 8, three months after tracheotomy, there was a striking decrease in the size of all the infiltrated structures. Very little edema could be seen. The cords remained fixed. However, the patient was discharged to his home, still wearing the tracheal tube and comfortable as far as the larynx was concerned.

Comment.—This case again illustrates that fixation of the vocal cord may follow an infiltrative lesion of the arytenoid cartilage. The patient is doing well at the time of writing despite the fact that there is involvement of the ileocecal region.

The next two reports concern cases in which tracheotomy was required for lesions which proved not to be strictly tuberculous, although there was suggestive evidence of tuberculosis in the larynx. I have seen a large number of nontuberculous lesions in tuberculous patients who were referred to the hospital because of hoarseness. Among the lesions noted were several benign neoplasms, most of which were vascular polypi, one nodule on the vocal cord, and two cysts; a large number of patients suffered from functional aphonia. The fear of laryngeal disease very likely influences this functional disturbance.

Case 10.—S. K., a man aged 39, was admitted to the hospital on Aug. 31, 1933. He had had pulmonary tuberculosis for two years. Hoarseness developed in March 1932, and the patient was taken to a hospital four months later because

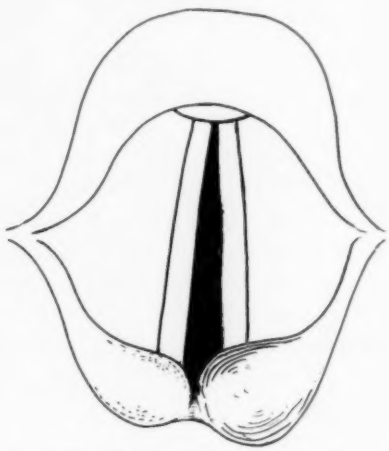

Fig. 9 (case 9).—Swelling of both arytenoid cartilages, more pronounced on the left side. The left vocal cord is completely fixed, and the right vocal cord is partly fixed.

of sudden laryngeal dyspnea. At that time biopsy of the larynx showed the presence of tuberculosis. The patient was therefore transferred to the Sea View Hospital, where examination revealed absence of most of the epiglottis and a large mass in the right side of the larynx superimposed on a similar irregular mass in the left side. Dyspnea was progressive, so that tracheotomy was performed on September 6. The postoperative course was uneventful. A biopsy specimen showed squamous cell carcinoma. The patient was transferred to the Kings County Hospital, where he was given roentgen treatment, which at first influenced his condition favorably. At the end of eighteen months, however, the patient died of carcinoma.

Case 11.—I. G., a man aged 64, was admitted to the hospital for the fifth time on Feb. 18, 1935. The pulmonary involvement had appeared four years previously. The sputum gave a positive reaction for tuberculosis at the time of the last admission to the hospital. Examination of the chest revealed the end-result of caseous tuberculosis involving the upper lobes of both lungs. There was

evidence of fibrosis and honeycombing in these areas. While in the hospital in December 1931 the patient had complained of slight laryngeal dyspnea. Some congestion of both vocal cords and a lagging of the tissues of the left side were noted. In March 1932 it was noted that dyspnea was present occasionally. "The interarytenoid space and vocal cords were red, swollen and thickened." In August 1932 another physician stated that the interarytenoid space was "red and irregularly edematous." In September 1932 the patient was admitted to the National Jewish Hospital in Denver. Examination by Dr. Robert Levy revealed bilateral paralysis of the abductor muscle. During the night of Jan. 28, 1933, there was a sudden attack of dyspnea, for which Dr. Levy performed a tracheotomy.

At the time of writing the larynx had the appearance of bilateral paralysis of the abductor muscle.

Comment.—It is difficult to diagnose the exact cause of laryngeal stenosis. There is a suggestion in the history of a tuberculous lesion of the larynx, possibly of the cricoid cartilage.

SUMMARY AND CONCLUSIONS

A series of cases of tuberculosis of the larynx is reported in which tracheotomy was required. Of 728 cases of laryngeal involvement in a total of 6,516 cases of pulmonary tuberculosis observed during a three year period tracheotomy was performed in 9.

Not every patient with pulmonary tuberculosis who becomes hoarse has specific involvement of the larynx. Several patients had been referred to the otolaryngologic service of a large hospital for the treatment of tuberculosis because they were hoarse, and on examination they were found to have a nontuberculous lesion, such as cyst, vascular polypi, paralysis and carcinoma. Not every patient with pulmonary tuberculosis who is hoarse has tuberculosis of the larynx, although this should be suspected.

Tracheotomy does not indicate a hopeless prognosis, nor does the presence of laryngeal involvement. Laryngeal involvement diminishes the prospect of recovery, but it does not mean that the patient is doomed.

Laryngeal obstruction is invariably caused by a productive lesion. The most frequent cause of laryngeal stenosis is a position of the vocal cord in the midline or almost in the midline, which is caused by fixation of the crico-arytenoid joint.

The prognosis is always better in those cases in which the pulmonary lesions show a tendency to recovery and in which the sputum contains few or no tubercle bacilli. The same conditions influence the prospect in a case of tuberculous involvement of the tracheotomy wound. When the tracheal wound comes in contact with a large amount of bacillus-laden sputum, it usually becomes infected.

Early and energetic attention to the involved larynx accomplishes much for these sufferers.

136 East Sixty-Fourth Street.

ABSTRACT OF DISCUSSION

DR. FRANK R. SPENCER, Boulder, Colo.: I am glad that Dr. Myerson emphasized the fact that laryngeal tuberculosis does not always offer a hopeless prognosis. Laryngeal tuberculosis may require emergency measures.

1. Edema may develop which increases rather rapidly during a few days or weeks. Sir St. Clair Thomson called this pseudo-edema. Since tuberculosis of the lung and larynx is nearly always bilateral, the edema may seriously interfere with breathing when it is extensive, and it therefore requires tracheotomy. 2. The swelling produced by perichondritis and chondritis often narrows the laryngeal lumen so much that tracheotomy is required to make the patient's last days as comfortable as possible. 3. Large tubercles on each side of the larynx often push the true cords so far to the median line that a picture of bilateral paralysis of the recurrent laryngeal nerve is produced. I doubt whether this should be called bilateral paralysis. I do not mean that it is impossible to have bilateral paralysis of the recurrent laryngeal nerve and tuberculous laryngitis; but this picture is not often one of true bilateral paralysis. 4. When syphilis and tuberculosis occur in the same larynx and at the same time, the danger of obstruction is greater than when either disease is alone. This is especially true if cicatricial contraction takes place as the syphilitic disease heals, and it usually does heal under treatment. 5. Tracheotomy is more frequently required if syphilis, tuberculosis and carcinoma are present concurrently. 6. Odynphagia is often in part relieved after the larynx is put at rest by tracheotomy. However, the patient and the laryngologist may both be disappointed with the result if this expected relief is the only indication for the tracheotomy.

In conclusion, tracheotomy for laryngeal tuberculosis, when definitely indicated, is a humane procedure. However, it should be done as an operation of election and not as a last minute emergency measure.

DR. GEORGE B. WOOD, Philadelphia: I have felt that with a few possible exceptions tracheotomy should be carried out on tuberculous patients only for the relief of dyspnea due to laryngeal stenosis. It is true that a certain amount of laryngeal rest is afforded by this procedure. The advantages, however, have not seemed sufficient to outweigh the disadvantages resulting from the operation. There is a strong possibility of serious infection of the tracheotomy wound, and in one of my patients a great part of the front wall of the trachea gradually sloughed out, so that the tube itself was not required. However, this patient's disease was in an advanced stage, with an enormous quantity of infected sputum.

As a method of therapy in early or only moderately advanced cases, I think tracheotomy is unjustifiable, as the disease can be cured or arrested in the majority of instances by electric cautery. In advanced cases in which there are ulceration, great destruction of tissue and no stenosis, I believe that the operation is contraindicated because of the great amount of infected sputum the patient has and the consequent likelihood of infection of the wound. But, as Dr. Myerson has pointed out, one occasionally sees a case of advanced laryngeal tuberculosis in which there is very slight pulmonary involvement, in which absolute laryngeal rest is strongly desired and in which tracheotomy might possibly be advisable. However, I never had a case in which I thought the operation would accomplish enough to warrant it. In all the cases in which I have performed a tracheotomy dyspnea was present, due to stenosis of the larynx. In two of the cases stenosis was due to recurrent bilateral paralysis of the laryngeal nerve. Involvement of this nerve possibly occurs more frequently than is supposed, and I wonder whether

some of the reported cases of fixation of the arytenoid cartilage are not really cases of paralysis of the abductor muscle.

There can be little difference of opinion as to the indication for tracheotomy when stenosis of the larynx is sufficient to produce distinct dyspnea. It is more difficult to decide at what time to perform the operation when stenosis is of a lesser degree. I believe that Dr. Myerson is right in his opinion that it is better to err on the side of an early operation if there is evidence that the laryngeal lesion is interfering with free inspiration. Electric cautery can be used with much less discomfort to the patient by means of the mirror, and I believe that the larynx can be as efficiently treated by this method as it can be by direct laryngoscopic observation. I never consider a condition in the larynx to be hopeless from the point of view of the lesion in the larynx itself unless the disease has actually spread beyond the confines of the larynx. If the disease has passed the aryepiglottidean fold, with possible involvement of the lateral glosso-epiglottidean ligament or the pharyngeal wall, the patient does not recover. Circumscribed pharyngeal tuberculosis, without laryngeal involvement, almost always yields promptly to electric cautery.

Dr. Gabriel Tucker, Philadelphia: My experience with tracheotomy in cases of tuberculosis of the larynx emphasizes the conclusions that Dr. Myerson has drawn from his series of cases. While rest of the larynx afforded by tracheotomy may not be complete, it has a beneficial effect on the disease process in the larynx. Laryngeal obstruction from any cause, whether it is inflammatory, neoplastic or an acute specific infection, such as tuberculosis, is palliated by tracheotomy. In all the cases of laryngeal tuberculosis in which I have performed tracheotomy I have done so because of obstruction to the passage of air in the larynx. In a recent case a man of 35 years had received cauterization of a tuberculous lesion in the larynx. This was followed by cicatrization to such an extent that the airway became obstructed. The pulmonary lesion in this patient was inactive. The patient gained 15 pounds (6.8 Kg.) in the first month after tracheotomy.

In one case of involvement of the wound by a tuberculous process there was profuse sputum heavily laden with tubercle bacilli. The wound finally healed, and the man was in good condition three years after the tracheotomy. The indication for tracheotomy when obstructive laryngeal dyspnea is present is the same whether the obstructing lesion is tuberculous, inflammatory or a neoplasm of the larynx. Any patient with an obstructive lesion in the larynx who is having difficulty in sleeping and awakens choking should have a tracheotomy. When a patient cannot sleep because of laryngeal obstruction it means that the involuntary muscles are not sufficiently strong to deliver the proper amount of air to the lungs and the patient awakens in order to bring the voluntary muscles into play. The method of tracheotomy in cases of laryngeal tuberculosis is important. The procedure is usually easily carried out because the neck is thin. The incision should be no longer than necessary. The trachea should be entered below the first ring by incision of three rings vertically in the midline; as few ligatures as possible should be used. The thyroid isthmus should be pulled up or down, without being divided if possible. The wound should be left open to heal by granulation. In order to keep the wound clean, the tube should be changed daily and the dressings every few hours.

Dr. Joseph I. Kemler, Baltimore: I can corroborate the remarks of Dr. Myerson and Dr. Wood on the prognosis and treatment of tuberculous laryngitis. I can only add that I know of no other disease that will clear up as quickly as

an early tuberculous lesion of the larynx, particularly the proliferating type, when treated with cautery.

I have performed three tracheotomies, two on patients with rather advanced disease. Tracheotomy had no influence on the progress of the disease. Two patients both died within six months. The larynx was a little better after tracheotomy than it was before the operation. In the third case, a young woman who had been under my observation for advanced laryngeal tuberculosis about fourteen years was cured and sent to a sanatorium. While there two years later, the larynx again became involved. Cautery was carried out, and cure was again effected. Four years later the real trouble began. Evidently there was more involvement of the larynx, which healed spontaneously but with marked cicatricial contractions. This is the only case I ever observed in which the contraction continued to obstruct breathing and a tracheotomy had to be carried out as an emergency measure. The patient was discharged from the sanatorium, as the pulmonary lesion was fibrosed; hence the disease was considered to be arrested. I gave the patient a tube containing the Iglauer diaphragm, which she used very comfortably; she spoke freely, with a very clear voice. I tried to remove the cannula, but neither she nor I was very anxious to accomplish it, as I was afraid to set up a new tuberculous process. The patient lived eight years in perfect comfort with the tube and died recently of an intercurrent disease.

Dr. M. C. Myerson, New York: I want to emphasize that because of misconceptions on the part of the average practitioner of medicine with regard to the subject of tracheotomy in tuberculosis of the larynx patients who have laryngeal dyspnea with this condition should not be denied the benefit of tracheotomy.

I avoided the discussion of technic or of timing the operation because I knew that the subject would be covered elsewhere.

RESEARCH REPORT ON EXPERIMENTAL AND CLINICAL SINUSITIS

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AND
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SYNOPSIS OF EXPERIMENTS

During 1934 and 1935 we continued our previous study (1930 to 1934) of the effects of surface applications to the normal and to the inflamed membranes of the frontal sinus of cats in which acute or chronic inflammatory changes closely resembling processes in man had been produced by inoculation with human strains of hemolytic streptococci. The technic and subsequent preparation of tissues was the same as that heretofore employed.

Study of the absorption of particulate matter into the membranes of the sinuses was carried on by chipping away the bony roof of the sinus and placing 5 per cent prussian blue in 4 per cent gelatin in some animals and in others full strength india ink outside the intact normal membrane. It was noted that numerous histiocytes were attracted to the region exposed to the ink and prussian blue; these remained crowded together for twenty-four hours, were spread out for some distance after forty-eight hours and were widely scattered and thinned out over the whole roof of the sinus after seventy-two hours. By this method a distinct accumulation of ink-laden histiocytes within definite lymph channels could not be demonstrated; but the immediate defense reaction of tissue phagocytes (histiocytes) was readily visible, even under low power magnification.

Reaction of the membranes of cats to histamine was tested as follows: by the injection of 0.001 mg. of histamine in solution outside an intact normal sinus membrane and in 4 per cent gelatin into a normal sinus cavity and by perfusion of a sinus infected for six weeks and a normal sinus three times at intervals of twenty-four hours with a solution of 0.001 mg. of histamine to 1 cc. of sterile distilled water. This agent, used outside the normal sinus, produced some thickening of the tunica propria, and used inside, great distention of the goblet cells. In the

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Read before the American Academy of Ophthalmology and Otolaryngology, Cincinnati, Sept. 17, 1935.

The Research was authorized and financed by the Council of the American Academy of Ophthalmology and Otolaryngology, from the Departments of Anatomy and Otolaryngology, University of Oregon Medical School.

chronically infected membrane severe acute exacerbation was produced by repeated doses in the sinus, but in normal membrane merely some edema was noted without mucosal damage.

Azochloramide, a chlorine-releasing antiseptic, in buffered 1 : 2,000, 1 : 5,000 and 1 : 10,000 solutions was perfused through normal and acutely and chronically infected sinuses; reparative effects were not noted after seventy-two hours, and the stronger solutions seemed to be definitely destructive to the mucous membrane.

Amino-acetic acid in a 2.5 per cent isotonic solution, because of its reported influence on the autonomic nervous mechanism, perfused through normal and chronically infected sinuses did not produce a reparative effect except to increase the number of goblet cells.

Acetylcholine (2.5 mg. to 5 cc. of sterile distilled water), which has been advocated for the treatment of ozena because of its stimulating effects on vasodilatation, caused congestion of the normal membrane and marked edema of the chronically infected membrane, without giving evidence of recent leukocytic migration or other signs of repair.

Amniotic fluid, used to promote defense reactions in the peritoneum, perfused at half and at full strength through acutely infected sinuses after forty-eight hours caused marked round cell infiltration and extravasation of blood, with great epithelial damage. After seventy-two hours changes were observed in chronically infected sinuses, with much less infiltration than that usually noted in membrane chronically infected. Apparently there was decided benefit.

Chlorophyll in an isotonic solution was irritating to acutely infected membrane but stirred up moderate exacerbation of inflammation of the sinus.

Sodium alum in a 1 per cent solution and tannic acid in a 0.5 per cent solution perfused through sinuses which were inoculated ten minutes later with hemolytic streptococci seemed to inhibit decidedly the severity of the acute infection.

Exposure of chronically infected sinus membranes to bare ultraviolet rays from a quartz mercury vapor lamp for one-half and one minute did not seem to produce a reparative change after seventy-two hours.

Production of absolute constipation during one hundred and twenty hours in order to promote the absorption of intestinal toxins into chronically infected sinus membranes did not give rise to an acute exacerbation of the sinusitis.

Ten new compounds, thought to have effects similar to those of ephedrine, were perfused through acutely infected sinuses in a 1 per cent solution. All the sinuses showed rather marked leukocytic infiltration. D-l-methylephedrine methiodide caused many eosinophils to appear, especially in the blood vessels, and numerous plasma cells.

Iso-amyl-di-methylamine methiodide caused marked infiltration by macrophages, plasma cells, leukocytes and some histiocytes. Similar changes were noted with benzyl-di-methylamine methiodide and hordenine methiodide. The most marked subepithelial reparative effect was noted with tetrandrine methiodide.

Our experiments of 1934 on the effect of unilateral cervical sympathectomy on chronically inflamed sinuses were repeated, with results similar to those then reported: severe exacerbation and engorgement on the side of the sympathectomy.

Study of mucosa from infected antrums and cyst walls from a man of 36 who had received heavy doses of high voltage roentgen rays (because of a suspected malignant process) revealed enormous thickening and fibrosis of the tunica propria, many plasma cells and almost normal epithelium.

Azochloramide in isotonic solutions of 1:5,000 and 1:10,000 proved somewhat irritating to the nasal mucosa of eleven patients when the antiseptic was used for irrigation of the antrums, provoking some swelling and sneezing. While it reduced the foul odor in some cases, it did not seem to reduce the amount of pus, and its use was discontinued because of its irritating qualities.

Isotonic solution of chlorophyll, injected into human antrums because of its stated properties of furnishing bacterial nourishment and thus freeing the infected membrane from attack, apparently increased rather than diminished the amount of exudate and odor in eight chronic cases; in two slight improvement was noted during its use. No complaint of irritation was made.

Much clinical improvement and cessation of discharge were noted in two cases of chronic infection of the antrums when full strength amniotic fluid was injected into the antrums several times following ordinary lavage. Discomfort was not experienced, but the curative effects of the lavage may have been responsible.

The quantities of the new ephedrine-type compounds were insufficient to use them in human sinuses, but it was noted that in 1 per cent solution all produced some shrinkage and blanching when applied to the inferior turbinate bones, especially iso-amyl-di-methylamine methiodide, benzyl-di-methylamine methiodide, tetrandrine methiodide and beta-phenylethylephedrine methiodide.

RECAPITULATION

Five years of investigation into the histopathology of experimentally produced sinusitis, with clinical application of certain data thus secured, have convinced us that owing to the defensive factors inherent in sinus epithelium and the connective tissue elements of its tunica propria almost every preparation applied to the surface of such membranes

becomes an irritant unless its strength is isotonic. Solutions stronger than normal are almost certain irritants, as are those which in any way interfere with ciliary action, no matter how well they may function as antiseptics in a test tube. Only a few chemical substances are favorable to the growth of cells and stimulate an influx of reparative histiocytes and leukocytes. An index of various substances and agents used during the series of studies, with the results, is appended to this report, and also a note detailing the technic of diathermy for sinusitis, as reported last year.

This year we have demonstrated that histiocytes take up particulate matter from the outer (bony) side of the sinus membrane as well as from the lumen of the cavity and that such matter is carried widely through the subepithelial tissue within seventy-two hours of its introduction, pointing to the likelihood of similar dissemination of bacteria in histiocytes.

Histamine in the normal sinus merely increases the flow of mucus; but apparently its presence in repeated doses causes severe acute exacerbation of chronic suppuration. We were not, however, able to produce this exacerbation by causing complete arrest of fecal elimination for five days; evidently in the cat under such circumstances a sufficient increase in histamine does not occur through the absorption of intestinal toxins to cause an exacerbation of existing lesions of the sinuses.

A new chlorine-releasing antiseptic, azochloramide, was noted to share the irritant properties of similar substances previously reported on, without stimulation of repair.

Reparative effects were not noted after the application of aminoacetic acid or acetylcholine to the surface, although the latter brought about marked edema of both the acutely and the chronically infected membranes. Solutions of chlorophyll caused severe acute exacerbation of chronic inflammation without reparative effects.

Amniotic fluid, half and full strength, caused marked congestion, leukocytic infiltration and early fibrous reparative changes, with diminution of the superficial destructive changes during seventy-two hours.

Astringents (sodium alum and tannic acid) used in weak solution inhibited greatly the severity of infection when such sinuses were subsequently inoculated.

Ten new compounds resembling ephedrine were observed to have slightly stimulating effects toward repair, notably iso-amyl-di-methylamine methiodide, benzyl-di-methylamine methiodide, hordenine methiodide and tetrandrine methiodide. All these produced slight blanching and shrinking of human mucous membrane, especially the latter three.

Proof of the excessive fibrosis caused by roentgen therapy was afforded by tissues from a man operated on for severe maxillary suppuration with the formation of cysts, who had received heavy dosage for a suspected malignant process.

Azochloramide in a 1:5,000 isotonic solution was too irritating for lavage of the antrum. Chlorophyll in isotonic solution proved helpful in only two of ten cases of chronic infection of the antrums. Much clinical improvement was noted in two cases in which amniotic fluid was used after lavage.

We do not think that further histopathologic study of sinus membranes of cats treated by the application of solutions to the surface will be profitable at present. Perhaps biochemists, physiologists and bacteriologists, with more extensive equipment and opportunities, may find it possible further to develop some of the lines of investigation which have opened during this and preceding years.

The anatomic problems of lymphatic drainage of the sinuses and of their autonomic innervation remain unsolved. These are difficult and delicate problems but are nevertheless of much importance in the interpretation of the physiology and pathology of the sinuses.

DETAILS OF EXPERIMENTAL STUDIES

The experimental work was carried out with the technical assistance of Mr. Wallace Shearer in the department of anatomy. The previous technic of inoculation and staining methods were followed, except that vital staining with trypan blue was not done of the membranes of cats 35-1 to 35-12 inclusive.

Spread of Particulate Matter Outside the Sinus Membrane.—In a series of normal cats the bone was chipped away over the intact membrane of the frontal sinus. In this area in cat 35-1 was deposited a 5 per cent solution of prussian blue in a 4 per cent solution of gelatin; the membrane was secured immediately. Full strength india ink was deposited on the membrane of cat 35-2, cat 35-3, cat 35-4 and cat 35-5, and the membrane was secured after one, twenty-four, forty-eight and seventy-two hours, respectively. The sections of membrane were lightly stained with hematoxylin and eosin, spread out and mounted full thickness on large slides. Very little absorption of the prussian blue was noted. After one hour the black mass was surrounded by histiocytes already laden with ink. The spread of the ink-laden histiocytes did not seem to follow definite channels, but they became more and more widely dispersed up to seventy-two hours, while the central mass grew progressivley smaller. Thus, particulate matter, and by analogy histiocytes bearing infectious matter which they may ingest from some focus, may be spread within seventy-two hours through a large portion of the tunica propria without a lesion of the epithelium.

Use of Histamine.—Cat 35-6.—Histamine, 0.001 mg. dissolved in water, was injected into the outer surface of the intact membrane of the right sinus, exposed by chipping away the bony wall, and the wound was sutured. The dose was

repeated after twenty-four hours. Histamine, 0.001 mg. in a 4 per cent solution of gelatin, was injected into the left sinus cavity, and the dose was repeated after twenty-four hours. Membranes were secured seventy-two hours after the first injection. A systemic reaction did not take place. With the injection from the outside, slight thickening of the tunica propria and some cellular infiltration occurred. The epithelium was thickened; goblet cells were numerous but not distended, and cilia were partially destroyed. In the area of injection into the sinus the membrane was normal except for distended goblet cells. Evidently this quantity of histamine is definitely irritating to the tunica propria but not to the epithelium.

CAT 35-8.—The right frontal sinus was inoculated with hemolytic streptococci, and purulent rhinitis developed, which lasted for five days after inoculation, followed by sneezing occasionally during six weeks, after which interval three injections of 0.001 mg. of histamine in 1 cc. of distilled water were made into the right (infected) and left (normal) sinuses, twenty-four hours apart. Membranes were secured seventy-two hours after the final injection. The cat was noticeably sick and irritable after the second injection of histamine. The right sinus, quiescent at the time of the first injection, was filled with purulent exudate twenty-four hours later. Following the second injection, the right side became so violently inflamed that pus exuded from the needle wound and appeared on the scalp. The third injection further aggravated both the local and the general condition of the animal. Grossly, the right sinus was full of a necrotic mass, while the left sinus membrane was merely somewhat congested and adherent to the bony wall at the site of the injections. Microscopically, the membrane of the right sinus showed a greatly thickened tunica propria, with edema and postinfectious fibrosis. Near the epithelial surface marked acute exacerbation of inflammation had occurred, with leukocytic infiltration, hemorrhage and destruction of epithelium. The membrane of the left sinus showed little change, except for an accumulation of fluid in the tunica propria, the epithelium remaining normal.

Use of Azochloramide.—This chlorine-releasing antiseptic in buffered isotonic solutions was perfused through the injection needle until the solution ran out of the nostril, after which the membranes were secured in seventy-two hours.

CAT 25-9.—A chronic infection was established in the right sinus for six weeks, and the left sinus was normal. No general effects were evident from the use of a 1:10,000 solution. Grossly, the usual chronic thickening of the membrane of the right sinus was observed. Microscopically, there was no evidence of an acute reparative effect in either membrane, that of the left sinus being quite normal.

CAT 35-11.—The right sinus was chronically infected, and the left was normal. After perfusion with a 1:5,000 solution, the animal seemed somewhat depressed. Grossly, the chronically infected membrane was thick but not adherent, with some purulent exudate in the sinus cavity. Microscopically, in addition to the usual chronic thickening and edema, there was acute injury to the epithelium, but without reparative leukocytic infiltration. The uninfected membrane showed severe epithelial destruction, thickening and injection, with recent fibrosis extending through the epithelium.

CAT 35-17.—There was acute infection of the left frontal sinus, which was perfused with a 1:800 solution. Grossly, this membrane was thickened and congested but not adherent, with the sinus cavity filled with a purulent exudate. The acute infection had caused edema and accumulation of round cells, with some leukocytes and plasma cells and early fibrosis; but the epithelium was much injured

and congested. Apparently this agent is an epithelial irritant and interferes with the normal process of repair, particularly in higher concentrations.

Use of Glycine.—Cat 35-10.—The right sinus was chronically infected, and the left sinus was normal. After perfusion with an isotonic (2.5 per cent) solution of amino-acetic acid, systemic reaction occurred. After seventy-two hours, the membrane from the chronically infected sinus showed the usual gross thickening without exudate, and that from the left sinus was normal. Microscopically, no evidence of a reparative effect of the injection could be made out, except for a large number of goblet cells.

Use of Acetylcholine.—Cat 35-12.—The right sinus was chronically infected, and the left sinus was normal. The membranes were secured seventy-two hours after perfusion with 2.5 mg. of acetylcholine in distilled water. The animal seemed much depressed after the injection, especially during the last twenty-four hours. The chronically infected membrane was thick, congested, adherent and full of necrotic exudate; the normal membrane was engorged, with blood at the site of the injection. Microscopically, the chronically infected membrane was greatly congested and edematous, but with little or no leukocytic infiltration; the epithelium was damaged, cilia were gone in patches, and there were numerous goblet cells. The uninfected membrane showed some thickening and distinct congestion of the tunica propria, with the epithelium normal save for numerous large goblet cells and some ciliary damage.

Use of Amniotic Fluid.—Cat 35-13.—Both frontal sinuses were acutely infected. The right sinus was perfused with amniotic fluid full strength, and the left was perfused with amniotic fluid diluted half with physiologic solution of sodium chloride. The animal had a severe reaction to the inoculation of streptococci forty-eight hours before and was much depressed when anesthetized for the perfusions of amniotic fluid. It died twenty hours after the perfusions. Both membranes were severely congested, and the sinus cavities were full of necrotic exudate. Microscopically, there was great infiltration of both membranes by lymphocytes, with much extravasation of blood and destruction of epithelium.

Cat 35-15.—Both frontal sinuses were chronically infected. The right side was perfused with amniotic fluid full strength and the left with amniotic fluid half strength. The membranes secured after seventy-two hours showed a general reaction. Grossly, the membranes of both sides were somewhat thickened and adherent, with a little purulent exudate in the right and less in the left cavity. Microscopically, aside from the usual chronic thickening and plasma cells, the tunica propria showed some active fibrosis, and little damage was apparent in the epithelium; apparently the effect of the amniotic fluid on these chronically infected membranes was distinctly beneficial.

Use of Chlorophyll.—Cat 35-16.—Chlorophyll in a buffered isotonic solution, 2 cc., was injected into the left frontal sinus, which was acutely infected. The membrane secured after seventy-two hours was somewhat thickened, with a moderate amount of purulent exudate. Microscopically, there were great thickening, hyperemia and polymorphonuclear infiltration, with ciliary destruction and much epithelial invasion by leukocytes; apparently it caused severe exacerbation of the acute inflammation, with no evidence of repair, possibly owing to the solvent used for the chlorophyll.

Cat 35-19.—Both sinuses were chronically infected. An injection was not made into the right sinus. The left sinus, into which 2 cc. of chlorophyll was injected, was grossly much thickened after seventy-two hours and still contained

the green solution mixed with exudate, which was more purulent than that present on the right side. Microscopically, there were marked thickening and edema with leukocytic infiltration, and numerous plasma cells were present. Apparently an acute exacerbation occurred, caused by the solution, but without much epithelial loss or reparative stimulation.

Prophylactic Effects of Sodium Alum and Tannic Acid.—CAT 35-14.—The sinuses were not infected. The right frontal sinus was perfused with a 0.5 per cent solution of tannic acid and the left frontal sinus with a 1 per cent solution of sodium alum. Ten minutes thereafter each sinus was inoculated with hemolytic streptococci. There was a slight mucopurulent discharge from both nostrils, but the cat was not sick at any time. After seventy-two hours the membranes were secured. A small amount of purulent exudate was present in each cavity; the membranes were not swollen or congested. Microscopically, with both prophylactic agents there was slight thickening and leukocytic infiltration of the tunica propria, but very much less than in membranes untreated prior to inoculation. The cilia were slightly damaged, but the epithelium was otherwise normal. Both sinus cavities were filled with pus.

Effects of Ultraviolet Rays from a Quartz Mercury Vapor Lamp.—CAT 35-18. —There was bilateral chronic infection of the sinuses. The roof of the sinus was chipped away, and the membrane was irradiated with a standard quartz tube point within the cavity of the right sinus for one minute and the cavity of the left side for thirty seconds. The scalp was sutured, and membranes were secured after seventy-two hours. Both cavities were thickened, and the membranes were very adherent; some purulent exudate was present on the right side. Apparently the chronic infection had been more severe in the right sinus. Microscopically, there was marked polymorphonuclear infiltration in the membrane of the right side, probably a secondary infection. None of the acute changes characteristic of a reparative process were observed.

Effects of Chronic Constipation.—CAT 35-20.—There was bilateral chronic infection. The cat was fed 0.1 Gm. of sodium bitartrate daily for one week, causing loose grayish stools after the fifth day. On the eighth day 5 mg. of powdered opium was given, and the dose was repeated until the eleventh day, when the dose was increased to 10 mg. for four days. Bowel movements ceased after the third day of administration of opium; and after one hundred and twenty hours of constipation, during which full meals had been consumed, the membranes were secured. The entire large intestine was filled with fecal material. Grossly, the sinus membranes were adherent, containing a little purulent exudate, but they presented no signs of acute irritation. Microscopically, the usual chronic changes were observed, with plasma cells and some fibrosis, normal epithelium and no evidence of acute exacerbation from any source.

Effects of Drugs Resembling Ephedrine on Acutely Infected Sinuses.—CAT 35-21.—There was acute bilateral infection. The right sinus was perfused with 1 per cent methylephedrine methiodide, and the left sinus, with 1 per cent d-l-methylephedrine methiodide. The animal was depressed following the injections. All membranes in this series were secured after seventy-two hours. The left side was more thickened, and both sides were congested. Microscopically, both membranes showed epithelial destruction and acute infiltration, but that from the left side showed numerous eosinophils, especially in the blood vessels.

CAT 35-22.—There was acute bilateral infection of small sinuses deep in cancellous bone. The right sinuses could not be perfused with 1 per cent beta-

phenylethyl-di-methylamine methiodide, which had apparently no effect in arresting the infection around the sinus in the cancellous tissue. The left sinus was perfused with 1 per cent d-l-pseudomethylephedrine methiodide. The membrane was thick and adherent and contained pus. Microscopically, there were marked thickening, fibrosis and edema, with leukocytic infiltration and epithelial destruction.

CAT 35-23.—There was acute bilateral infection. The right sinus was perfused with 1 per cent iso-amyl-di-methylamine methiodide and the left sinus with 1 per cent p-phenyl-beta-hydroxyethel-di-methylamine methiodide. The infection was severe, the animal was much depressed, and the membranes were greatly congested and full of pus, chiefly on the right side. Microscopically, on the right side there were severe acute infection and marked epithelial destruction, and the tunica propria was filled with macrophages, plasma cells and leukocytes. The left sinus showed infiltration, and the reparative effects were less marked.

CAT 35-24.—There was acute bilateral infection. The right sinus was perfused with 1 per cent benzyl-di-methylamine methiodide and the left sinus with 1 per cent hordenine methiodide. The animal was unaffected by the experiment; there was slight nasal discharge when the perfusions were done; the membranes were not adherent, and there was little exudate. Microscopically, the right sinus showed numerous lymphocytes, plasma cells and some histiocytes. The epithelium was almost destroyed. The left sinus showed marked infiltration by plasma cells, lymphocytes and some histiocytes; the blood vessels were engorged and the epithelium was full of leukocytes and nearly destroyed.

CAT 35-25.—There was acute bilateral infection. The right sinus was perfused with 1 per cent tetrandrine methiodide and the left with 1 per cent beta-phenylethylephedrine methiodide. The animal was somewhat depressed during the experiment. The membrane of the right sinus was decidedly congested, containing much pus. The membrane of the left sinus was not congested, and there was little exudate. Microscopically, the membrane of the right side, was thickened, with a barrier of leukocytes especially just below and in the epithelium, which was somewhat injected; there were some plasma cells and histiocytes in the deeper layers of the tunica propria. The membrane of the left side showed less marked reparative effects, with little epithelial damage.

Effects of Unilateral Cervical Sympathectomy.—CAT 35-7.—There was acute bilateral infection, with nasal discharge developing on the second day. The animal was given 2 cc. per kilogram of body weight of an 11 per cent solution of sodium barbital seventy-two hours after inoculation. With the cat under complementary ether anesthesia the cervical portion of the right sympathetic trunk was severed, and membranes were secured forty-eight hours thereafter. Both sinuses were filled with purulent material, but on the right side the membrane was much thicker, and pus was oozing out through the needle wound. This confirmed on acutely infected membranes our observations of last year respecting exacerbation caused by sympathectomy on chronic infection of the wall of the sinus.

Effects of High Voltage Roentgen Therapy on Human Maxillary Mucosa.—Tissues, secured by a Caldwell-Luc operation from the maxillary sinus of a man of 36 who had elsewhere received during five months several courses of high voltage roentgen therapy for a suspected malignant process diagnosed from roentgenograms, showed extreme toughness and adhesion of the mucosa and cyst walls to the dry and ischemic maxillary bone. Microscopically, the epithelium was about normal, but the tunica propria was excessively thickened and fibrotic, with few

infiltrating cells save some subepithelial eosinophils. A cyst wall was highly edematous and fibrotic, with numerous plasma cells and normal epithelium.

APPENDIX 1

Technic Employed for Treatment of Sinuses by Diathermy.—Because of numerous requests, the following details are supplied by Dr. Arthur C. Jones, who administered the treatments in our 1934 series of cases.

The current is applied to the frontal and maxillary regions through a set of electrodes shaped to fit smoothly over the sinuses. (Medium weight electrode foil is used.) The electrode for the forehead is ovoid, about 1 by 2½ inches (2.5 by 6.2 cm.), with the corners well rounded. A small strip connects this electrode with the two which overlie the maxillary sinuses, the strip being about 1 inch long by ¼ inch (0.6 cm.) wide, applied over the glabella and down along the bridge of the nose. The plates which fit over the maxillary sinuses are shaped like an oval, with a stem extending upward and medially to overlap the small plate that lies along the bridge of the nose. These plates are molded to the maxillary regions so that they fit smoothly, and the stemlike portions are molded down on the bridge of the nose and strapped to the connecting piece, which in turn is attached to the frontal electrode with adhesive tape. The clip of the electrode is then attached to one end of the frontal electrode, the skin underneath being protected from pressure by a bit of heavy rubber, and then a shaped piece of rubber sponge is placed over the frontal and each maxillary electrode.

The patient holds the rubber sponges over the maxillary plates, while the technician wraps an elastic bandage around the forehead to hold the frontal plate in place and then around the face to hold the maxillary plates. A plate about 3 by 4 inches (7.5 by 10 cm.), with well rounded corners, is applied to the back of the neck and attached to the other treminal. I usually apply a liberal amount of electrode compound jelly beneath the plates before they are finally bound on.

The treatment lasts from thirty to forty minutes, and the milliamperage must be within the heat tolerance of the patient. Since margins for diathermy vary, I cannot give the exact milliamperage, but with the Victor variofrequency apparatus this dosage is between 700 and 750 milliamperes.

Treatments are given daily for the first week and then three times a week. They are always preceded by some procedure for shrinkage to insure as good drainage as possible. If there are symptoms of increased temperature, pressure in the sinuses or pain, the treatment is either very much modified as to dosage or discontinued until drainage can be instituted. A rise of temperature is almost positive proof of encapsulated pus in one or more of the treated sinuses. A series of from twelve to twenty diathermy treatments is given, and the clinical condition of the patient of course determines the question of further treatment.

APPENDIX 2: INDEX OF ACADEMY RESEARCH ON SINUS MEMBRANES, 1931-1935

MEMBRANES OF THE FRONTAL SINUSES OF THE CAT

Normal anatomy and histology, vital staining methods, 1931
Method of producing acute infection, 1931; chronic infection, 1932
Diet, negative effects on progress of infection, 1933
Lymphatics, 1934; spread of particulate matter external to membrane, 1935

Destructive effects on epithelium: mechanical trauma, 1931; heat, 1931; paraffin, acacia, 1931; soap jelly, glucose half-strength, coconut oil, mucilage of chondrus, U. S. P., magnesia magma, calcium hydroxide, calcium lactate, scarlet red + oxyquinoline sulfate, 1932; typhoid vaccine, merthiolate, alcohol, mercurochrome, di-chloramine, tri-nitrophenol + calcium gluconate, 1934; azochloramide; chlorophyll, amniotic fluid, 1935

Destructive effects on tunica propria; mucilage of chondrus, U. S. P., 1932; chlorophyll, 1933

Negative effects except on cilia; mucilage of tragacanth, liquid petrolatum emulsified with agar, glucose full strength, sodium phosphate, 1932

Negative effects except increase of goblet cells; di-chloramine, 1932, histamine, 1935

Negative effects on epithelium: roentgen ray, 1933, 1935

Negative results: amino-acetic acid, irradiation from quartz roentgen vapor lamp, chronic constipation, 1935

Acute exacerbation produced by cervical sympathectomy, chronic, 1934; acute, 1935

Acute exacerbation in chronically infected membranes: histamine, acetylcholine, chlorophyll, 1935

Reparative effects on tunica propria: mobilization of histiocytes by infection plus trauma, 1931; magnesia magma, calcium hydroxide, calcium lactate, 1932

Intradermal vaccination, 1932; failure to arrest infective process, 1934; peptone, subject's own blood subcutaneously, 1934

Round cell infiltration: destroyed by roentgen rays, 1933; increased by intradermal vaccination, 1932; by mercurochrome, metaphen, 1934; by drugs resembling ephedrine, 1935

Plasma cell infiltration, in most chronic infections, 1931-1935

Fibrosis: roentgen rays, 1933

Prophylaxis against infection: sodium alum, tannic acid, 1935

MAXILLARY SINUS MEMBRANES OF MAN

Normal histology, 1931; differential staining, 1932

Reticulo-endothelial system: inflammatory changes, 1931

Destructive effects on epithelium: magnesia magma; physiologic solution of sodium chloride, 1935; irradiated oil, 1933

Edema of tunica propria caused by sodium and chlorine, 1932

Reduction of edema by calcium and magnesium, 1932, 1933

Reduction of congestion of the mucosa: ephedrine-like drugs, 1935

Increase of congestion of the mucosa: diathermy, 1934; acetylcholine, 1935

Reparative effects on the tunica propria: (*a*) mobilization of histiocytes: magnesia magma, 1932; calcium gluconate, 1933; diathermy, 1934; ephedrine-resembling drugs, 1935; (*b*) marked plasma cell infiltration: magnesia magma, 1932; calcium salts, 1933; diathermy, 1934; (*c*) fibrosis: magnesia magma, 1932; calcium salts, 1933; roentgen ray, 1933, 1934, 1935; diathermy, 1934

Dr. Franz Schmelkes of Wallace & Tiernan, Inc., gave the supply of azochloramide; Dr. R. F. Ridpath and Dr. Benjamin Gruskin, Temple University, gave the supply of, and information regarding, chlorophyll solution; Dr. K. K. Chen of the Lilly Research Institute gave the supply of new ephedrine-resembling compounds, and Dr. Charles Armstrong, United States Public Health Service, gave information regarding the inhibitory effect of astringent drugs on subsequent mucosal infections caused by viruses.

PUNCTURE OF THE INTERNAL JUGULAR VEIN IN CASES OF MASTOIDITIS

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The cerebrospinal fluid pressure as determined by lumbar puncture is used as a routine as a measure of intracranial pressure. For otolaryngologic purposes, the Queckenstedt or Tobey-Ayer [1] test is used to ascertain the degree of obliteration of the lateral sinus by thrombosis in cases of mastoiditis. In a summary of results obtained during twelve years at the Massachusetts Charitable Eye and Ear Infirmary, Meltzer [2] found the Tobey-Ayer test valuable and reliable in approximately from 70 to 80 per cent of the cases and a complete failure in 18.2 per cent. He considered this test one of the best diagnostic aids in cases of thrombosis of the lateral sinus.

The Queckenstedt and Tobey-Ayer tests are of special importance in the differentiation between the two lateral sinuses when both mastoids are involved. Under these conditions the percentage of failure is highest and the tests less accurate in determining obstruction due to thrombosis. The inherent weaknesses of these tests are:

1. Venous pressure and obstruction are being indirectly measured in the Tobey-Ayer or Queckenstedt test through the measurement of cerebrospinal fluid pressure by lumbar puncture.

2. The anatomic differences between the two lateral sinuses make the height of rise on compression difficult to interpret. Edwards,[3] in his study of the anatomic variations of the cranial venous sinuses, pointed out that there is considerable variation in the sizes of the two lateral sinuses. In 92 per cent of skulls that he had examined there was a marked difference in the diameters of the outgoing venous sinuses of the two sides. In some cases the ratio was as high as 4:1. In addition to a change in caliber, there was also a difference in length—the left venous sinus was always longer. Edwards concluded that there is a definite anatomic basis for the fact that the greater percentage of

1. Tobey, George L., Jr., and Ayer, James B.: Dynamic Studies on the Cerebrospinal Fluid in the Differential Diagnosis of Lateral Sinus Thrombosis, Arch. Otol. **2**:50 (July) 1925.

2. Meltzer, Philip E.: Treatment of Thrombosis of the Lateral Sinus, Arch. Otolaryng. **27**:131 (Aug.) 1935.

3. Edwards, Edward Allen: Anatomic Variations of the Cranial Venous Sinuses, Arch. Neurol. & Psychiat. **26**:801 (Oct.) 1931.

manometric tests showed a greater response to compression of the jugular vein on the right. There is therefore always a question of doubt as to the accuracy of the test by lumbar puncture for obstruction of the lateral sinus, because of the possibility of anatomic variation in the two sinuses.

3. There is danger of possible death from the presence of a subtentorial abscess or tumor when lumbar puncture is done.

4. There is danger of precipitating acute meningitis when lumbar puncture is done in the presence of a possible septicemia.

The indirect measurement of venous obstruction by lumber puncture allows for a number of extraneous factors which frequently nullify the value of this test—change of position, nervousness, unequal compression of the neck for the two sides over the vein and other possible factors which may occur in individual cases.

The anatomic differences are so definite that one cannot possibly allow for them properly in any one instance, because one side, frequently the right, will give a higher response to compression.

The danger of doing lumbar puncture in the presence of a subtentorial abscess or tumor can be guarded against in cases in which such a process after careful examination is thought to be present.

The precipitation of acute meningitis by doing lumbar puncture in the presence of a possible thrombosis in the lateral sinus is probably more theoretical than real, because it probably requires a considerable number of organisms of great virulence, together with the withdrawal of a considerable amount of fluid by lumbar puncture, to precipitate meningitis in this manner. I have never known or heard of a case in which this combination of circumstances has occurred.

Within this past year, in a series of cases of mastoiditis at the Boston City Hospital and the Beth Israel Hospital of Boston, I have practiced puncture of the internal jugular vein and manometric measurement of venous pressure with compression of the neck below according to the method described by Myerson and Loman [4] in a report of their work done in cases of mental disease at the Boston State Hospital. I thought that this test might be more accurate and individual for each side, in view of the anatomic variation in the size of the two lateral sinuses, and because the puncture is made nearer to the source of infection it might be a direct measure of the venous pressure and might help in the evaluation of the presence or absence of block by a thrombus in the lateral sinus. Myerson and Loman measured and described three factors in intracranial dynamics in man—the arterial pressure, the venous pressure and the cerebrospinal fluid pressure as measured by

4. Myerson, A., and Loman, J.: Internal Jugular Pressure in Man: Its Relationship to Cerebrospinal Fluid and Carotid Arterial Pressures, Arch. Neurol. & Psychiat. **27**:836 (April) 1932.

puncture of the internal jugular vein and ordinary lumbar puncture. On compression of the neck they obtained approximately equivalent ratios of rise in the venous pressure in the internal jugular vein and the cerebrospinal fluid pressure. This I have repeated and found to be generally true. In my first cases puncture was done with the patient under ether anesthesia and because of that the rises in pressure were necessarily higher. In my recent cases puncture was done under local anesthesia. Relatively the conclusions were the same.

Quoting from the description of the method employed by Myerson and Loman, the procedure is carried out as follows:

> The internal jugular vein is selected as it courses near the tip of the mastoid on its way downward from the jugular foramen. At this point the vessel is large, fairly constant in position and very close to the skull and receives no tributaries from the face or neck. . . . The best position of the head and neck for this puncture is with the patient on his side, the opposite side of the face well supported by a pillow and the head somewhat extended on the neck. A needle of 18 gage and 40 mm. in length is thrust into the tissues of the neck, which have been well anesthetized, at the juncture of the tip of the mastoid with the anterior border of the sternocleidomastoid muscle. The point of the needle is slid over the tip of the mastoid and thrust perpendicularly into the tissues of the neck to its full extent. It is then slowly withdrawn, suction being made on a Luer syringe that is attached to the needle. As the needle is slowly withdrawn, the venous blood of the jugular vein is drawn into the syringe. The syringe is immediately disconnected, and an Ayer manometer such as is used for measuring cerebrospinal fluid pressure is connected with the needle and held perpendicularly to the side of the neck.

The needle should penetrate the vein in the first attempt. To avoid clotting, the manometer should have a citrate solution washed through it. If the lateral sinus is patent, compression of the neck below the point of entrance of the needle will immediately cause a measurable rise in the manometer. The blood drawn into the syringe before the manometer is connected is laid aside for culture. It is possible that because the puncture is made nearer to the source of infection a higher percentage of positive blood cultures may be obtained.

Experience with this procedure has been eminently satisfactory. Much variation in the reaction to compression has been noted. Frequently the initial pressure may be low, from 40 to 100 mm., sometimes less than 40 mm. It is more often high when puncture is done with the patient under general anesthesia. Occasionally the initial pressure will not be high enough to register in the manometer. A few cubic centimeters of a citrate solution introduced into the manometer will allow a reading which it will be possible to compare with the reading obtained on compressing the neck below the site of puncture of the jugular vein. Or, with the patient on his back and an elbow obturator attached to the needle, a reading will be made possible. The proportional difference between the initial pressure reading so obtained and the read-

ing obtained on compression of the jugular vein still varies relatively as the difference between the initial pressure determined by lumbar puncture and the reading obtained on compression of the jugular vein below.

This procedure has been carried out in twenty-five cases of mastoiditis. Readings were taken before and after compression of the neck. Some of these readings were made on the operating table just before the operation, when the technic was being tried out, and its correspondence with the results of lumbar puncture tests evaluated. Table 1 presents an exact record of ten cases of mastoiditis in which puncture of the jugular vein was used. The results in cases in which puncture

TABLE 1.—*Data in Ten Cases of Mastoiditis in which Pressure in the Internal Jugular Vein was Measured*

Patient	Age	Diagnosis	Initial Pressure*	Compression	Fall
Under general anesthesia					
C. N.	17 mos.	Mastoiditis on right side.....	R.J., 100 L.J., 80	140 120	100 90
J. T.	7 yrs.	Mastoiditis on left side; lateral sinus thrombosis	L.J., 50	70	Slow 60
L. L.	26 yrs.	Thrombosis on left side.....	L.J., 50	70	Slow 50
E. B.	10 yrs.	Mastoiditis on right side.....	R.J., 0	120	
M. H.	9 yrs.	Lateral sinus thrombosis on right side	R.J., 20	50	Slow 20
F. D.	27 yrs.	Chronic mastoiditis	R.J., 200	Rapid 500	Rapid 200
Under local anesthesia					
P. G.	4 yrs.	Mastoiditis on right side.....	R.J., 35	350	Rapid 35
J. F.	54 yrs.	Chronic mastoiditis	L.J., 35	180	Rapid 35
T. P.	30 yrs.	Acute mastoiditis on right side	R.J., 35	250	Rapid 35
R. T.	40 yrs.	Acute mastoiditis on both sides	R.J., 0 Collapsed vein L.J.	Right 0 Left 250	... 100

* R.J. indicates right jugular vein and L.J., left jugular vein.

was done under local anesthesia were compared with those in which it was done under general anesthesia. When there was no evidence of thrombosis of the lateral sinus, the rise of pressure on compression was significant, and the fall on relaxation of compression was quick and comparable to the rise. The exact magnitude of the rise and fall varied with each individual case, probably owing to individual and external factors, much the same way as it does in the Tobey-Ayer test with lumbar puncture. The value of this test lies in the significant rise and fall present in cases without thrombosis; for in cases of thrombosis of the lateral sinus, obliterative or partial, there was either no rise and fall or a definitely slight rise and fall.

According to table 1, three patients (J. T., L. L. and M. H.) with thrombosis showed low pressure and a slow rise and fall; these patients all had partially obliterating thrombi. R. T. had a completely collapsed vein

on the right, which it was impossible to measure because there was no rise or fall in pressure. On the left the vein was free, and the rise and fall were significant. On operation a completely obliterative thrombus of the right lateral sinus was found.

In our series of cases in which the pressure in the internal jugular vein was compared with spinal fluid pressure it was found that the initial pressure in the internal jugular vein was generally lower than the spinal fluid pressure, but that the rise in pressure on compression of the neck was proportionately the same in both instances. There was much individual variation owing to the same factors operative in lumbar puncture tests. Here again the importance of these tests lies not so much in the exact magnitude of rise as in the fact that a material rise establishes patency, and a failure to rise materially, a probable obliteration of the

TABLE 2.—*Relationship of Pressure in the Internal Jugular Vein to Cerebrospinal Fluid Pressure* *

Patient	Disease	C.F.P.	Comp. Rise	I.J.P.	Comp. Rise
C. N.	Mastoiditis on right side.....	150	250	100	140
J. T.	Mastoiditis on left side; lateral sinus thrombosis	100	120	50	70 slow; left side
L. L.	Mastoiditis on left side; lateral sinus thrombosis	110	130	40	70 left side
E. B.	Mastoiditis on right side.....	100	300	40	120
F. D.	Mastoiditis on right side.....	100	150	20	50 left side
M. G.	Mastoiditis on right side.....	200	600	150	500
C. G.	Mastoiditis on right side.....	100	300	30	250
P. G.	Mastoiditis on right side.....	120	400	35	350

* C.F.P. indicates cerebrospinal fluid pressure; I.J.P., pressure in the internal jugular vein, and Comp. Rise, compression rise.

lateral sinus by a thrombus. The difficulty in decision is not so great in cases of complete obliteration of the sinus. It is hoped that because the puncture is made nearer to the source of infection this test may be more helpful in those cases in which the lateral sinus is only partially obstructed by a thrombus.

In table 2 are presented comparative measurements of the pressure in the internal jugular vein and the cerebrospinal fluid pressure in cases of mastoiditis. In two of these cases there were partially obstructive thrombi, and the rise and fall in pressure were similar by both methods. In two cases (J. T. and L. L.) in which thrombi were found in the lateral sinuses, although not completely obliterating them, the low pressure and rise are significant by comparison with the measurements of the cerebrospinal fluid pressure.

Other very interesting possibilities have been suggested in the carrying out of this test. In one case it was impossible to obtain blood by puncture of the jugular vein after repeated attempts, although puncture

was successful on the opposite side. It was thought that the technic of puncture on the side where the mastoiditis was present might be at fault. However, operation revealed that there was an entirely collapsed jugular vein owing to a completely obliterating thrombosis on that side. This raised the presumption that in a given case of mastoiditis with chills and fever indicative of probable thrombosis of the lateral sinus, repeated unsuccessful attempts at puncture of the jugular vein or lack of a rise in pressure on that side presupposes a collapsed jugular vein owing to thrombosis of the lateral sinus—a point of distinct diagnostic value. To make this proof more positive, a needle was introduced into the opposite jugular vein and a rise in the manometer successfully elicited by pressure on the vein below the point of puncture. This established patency of the lateral sinus for that side.

Another interesting finding in the presence of mastoiditis on both sides was brought about by introducing the needle into one jugular vein and compressing the jugular vein on the contralateral side. A rise in the manometer presumed both lateral sinuses to be free from occluding thrombosis and made it unnecessary to test the side in which the needle had not been introduced. In carrying out this test care must be taken to cause compression over the internal, not the external, jugular vein, else through collateral circulation a rise on the opposite side could be obtained in the presence of a thrombus in the lateral sinus.

SUMMARY

Puncture of the jugular vein with manometric measurement of venous pressure is described and compared in value with the measurement of the cerebrospinal fluid pressure by the Queckenstedt or Tobey-Ayer test in cases of mastoiditis complicated by a thrombus in the lateral sinus.

The advantages urged in favor of puncture of the jugular vein are:

1. Each lateral sinus may be tested individually. This eliminates the consideration of anatomic differences in the veins and helps to exclude extrinsic factors of interference which occur when the lumbar puncture method is used.

2. Since the puncture is nearer the source of infection, greater accuracy may be expected.

3. The possibility of puncture on one side and contralateral compression of the neck on the other side as a means of establishing the patency of both lateral sinuses through one venous puncture is suggested.

4. At the site of puncture of the jugular vein near the source of infection blood may be more accurately and easily obtained, and cultures may possibly more often show positive results.

VENTRICULAR PUNCTURE

PRELIMINARY TO OPERATION FOR ACUTE SUPPURATIVE PETROSITIS

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Recently great interest has been aroused in all phases of suppuration of the petrous pyramid. Critical observers are gaining a clearer insight into the disease. Assuring reports are now forthcoming to support the view that suppuration within the petrous bone has a marked tendency to spontaneous cure. However, in the instances in which surgical intervention becomes imperative it is logical to employ an approach which makes it possible to drain that part of the pyramid in which disease most often occurs.

Our microscopic sections of temporal bones show that in the vast majority of cases of suppuration of the petrous pyramid the infection spreads from the middle ear and antrum through the superior and posterior perilabyrinthine groups of cells and that the greatest expression of the disease is situated between the superior semicircular canal and the internal auditory meatus. It is obvious, then, that the surgical approach for the drainage of the suppurative focus should be directed first to this portion of the pyramid. The approach to this area offers at the same time an approach to the region of the apex. The apex, however, is frequently not diseased and is only rarely more involved than the more lateral portion of the pyramid.

We have adopted a procedure described by Eagleton, with a few modifications, which is performed without doing a radical mastoidectomy. It consists of a temporal decompression after a thorough and complete simple mastoidectomy. If one can adequately retract the dura from the superior petrosal surface, an excellent opportunity to inspect the entire superior petrosa, including the apex, is afforded. At the same time the posterior petrosal surface can also be explored for some distance. This procedure is performed under direct vision and has the cardinal merit of preserving the function of the ear. It does not carry with it the apprehensive dread of injury to such important structures as the cochlea and the carotid artery.

The incision for the decompression operation is extended upward about 3 inches (7.5 cm.) from the upper angle of the mastoid. A second incision is made about 2 inches (5 cm.) directly backward from the

From the Otological and Neurosurgical Services of Mount Sinai Hospital.

middle of the incision in the mastoid toward the external occipital protuberance. The squama is then removed. The bone overlying the cerebellum and sinus is removed as far forward as the posterior semicircular canal. The bone between the middle and the posterior fossa must be completely removed, as well as the middle plate of the fossa over the antrum and aditus as far as the superior semicircular canal. Brain retractors are used to lift the dura away from the bone. With a Cameron light and suction one can inspect almost the entire superior petrosal surface and a great portion of the posterior petrosal surface.

In order to facilitate the lifting of the dura from the bone preliminary puncture of the lateral ventricle on the side opposite to the petrositis was suggested and tried by one of us (A. K.). Emptying the lateral ventricle to reduce intracranial pressure is not a novel procedure. In most neurosurgical clinics the lateral ventricle is tapped during some stage of every suboccipital craniotomy. The reduced dural tension that follows is of great help in the exposure which we use.

To our knowledge, this preliminary step of ventricular puncture as part of the operation for suppuration of the petrous pyramid has not been mentioned or suggested heretofore. The ease with which the dura is stripped up from the bone after emptying of the opposite lateral ventricle leads us to present the practical and theoretical advantages of this procedure. In illustration the following case is reported:

REPORT OF A CASE

History.—Evelyn B., aged 6 years, was admitted to Dr. Friesner's service on Feb. 5, 1935, with the diagnosis of acute suppuration of the right petrous pyramid.

Four weeks before admission, after a mild attack of scarlet fever, both ears began to discharge spontaneously. After two weeks the purulent discharge from the left ear ceased, but the discharge from the right ear continued as previously. About this time the child began to complain of intermittent frontal headaches, which increased in severity, and also of pain over the right eye. Five days before she entered the hospital she began to see double, and it was observed that there was a palsy of the right external rectus muscle. Three days later she vomited twice, and on the following day she vomited again. There were no convulsions or chills. The temperature at the time of admission to the hospital was 100.2 F.

Examination.—This showed a thin, pale, acutely ill child who was alert and well oriented but unusually sensitive and irritable. She cried most of the time, holding the hand over the right side of the forehead. The pupils were equal and regular and responded well to light and in accommodation. There was definite weakness of the right external rectus muscle but no nystagmus. The vessels and disks of both fundi oculi were normal. There was no demonstrable facial weakness. The rest of the general examination showed nothing abnormal.

Left Ear: The drum was intact; it was slightly thickened in Shrapnell's membrane but elsewhere was flat and gray. No discharge was present, and there was no tenderness of the mastoid. The landmarks were visibly returning.

Right Ear: The drum was full, and the landmarks were absent. There was slight mucopurulent discharge from an anterosuperior perforation, through which a small granuloma protruded. There was no tenderness in the mastoid or edema.

Laboratory Studies: The urine was normal. The white blood cells numbered 14,000 per cubic millimeter, with 90 per cent polymorphonuclear cells. The hemoglobin content was 60 per cent. The spinal fluid was clear but showed some red cells on microscopic examination; the sugar content was 80 mg. per hundred cubic centimeters, and the chloride content, 770 mg. per hundred cubic centimeters, but no organisms were found on smear or culture.

Diagnosis: The diagnosis was acute suppuration of the right petrous pyramid.

Preliminary Ventricular Puncture (Dr. Abraham Kaplan).—The entire head was shaved; the patient was placed in the semisitting position, and after preparation of the scalp with iodine and alcohol, 10 cc. of a 1 per cent solution of procaine hydrochloride was infiltrated over the left postparietal region. A vertical incision about 1½ inches (3.8 cm.) long was made through the infiltrated area. A trephination through the skull brought to view normal-appearing dura, which pulsated freely. A ventricular needle was then inserted through the dura for a distance of 3.5 cm., with the escape of 30 cc. of clear ventricular fluid. No ill effects were noted during the emptying of the ventricle. The wound was then closed in double layers, and a small dressing was applied, sealing off the wound so as not to interfere with the main procedure.

Operation for Suppuration of the Petrous Pyramid (Dr. Samuel Rosen).—After the patient was fully anesthetized with ether the right mastoid region was draped in the usual manner. A complete simple mastoidectomy disclosed only a slight amount of pus in the initial groove, but the remainder of the mastoid was not diseased. The plate over the lateral sinus was then removed. Further exploration of the zygoma, the peribulbar cells and the solid angle failed to reveal any disease. The superior and posterior semicircular canals were then exposed. An incision about 3 inches long was then directed upward from the upper angle of the incision in the mastoid, and then another incision 2 inches long was directed backward from the middle of the wound in the mastoid toward the external occipital protuberance. After retraction of the soft parts a decompression was begun by removing the squama and adjacent bone to expose the sinus and the cerebellar dura as far as the posterior semicircular canal. In separating the dura from the floor of the middle fossa it became evident that the ease with which this could be accomplished greatly facilitated the operation and allowed for a liberal exposure. The roof of the antrum and aditus and the zygoma were cut away with a rongeur without difficulty. With the use of narrow brain retractors the flaccid dura was easily elevated so that one had an excellent exposure of the superior surface of the petrosa.

When the superior semicircular canal was exposed a small, pale granuloma was seen protruding between it and the plate of the superior petrosal surface. Removal of the granuloma was immediately followed by a gush of thick, yellow pus under pressure. A probe which was inserted into the defect entered a cavity anteriorly and internally for almost 5 cm. Evidently the infection had primarily involved the supraposterior perilabyrinthine cells and so entered the body of the petrosa, gradually extending into and involving the apex. An epidural abscess just internal to the superior semicircular canal was encountered. From this point toward the apex the plate of the middle fossa was removed for almost an inch (2.5 cm.). One could then inspect a large cavity in the pyramid filled with granuloma and pus. This cavity was thoroughly cleaned out with a curet, a

rubber dam drain inserted into it and another larger rubber drain placed between the exposed petrosa and the dura.

A smear and culture of the purulent material showed Streptococcus haemolyticus-beta and Staphylococcus aureus. Bone from the superior surface removed at operation showed acute osteomyelitis.

Course.—The postoperative course was gratifying. Headaches ceased on the day after the operation, and the palsy of the rectus muscle began to improve two days later and the muscle was normal one week later. After a fortnight there was no longer any discharge from the right ear. On the forty-seventh postoperative day all the drains were removed. The patient was discharged on March 30, free from symptoms, with no abnormal signs and the wound completely healed.

COMMENT

One may well ask: What are the dangers and advantages of a ventricular puncture preliminary to an operation for suppuration of the petrous pyramid, as compared with spinal puncture? Although there is limited experience from which to make such comparisons, there are some theoretical considerations which should be discussed regarding this new proposal. The contentions are as follows:

1. Emptying of the lateral ventricle in the hands of an experienced neurosurgeon is attended with very little risk. Over one hundred consecutive ventriculographies have been performed at the Mount Sinai Hospital without any serious complication. If one remembers that the procedure was performed on patients in whom an intracranial neoplasm was suspected, and in many instances found, it must be clear that the danger of simple drainage of the lateral ventricle is almost negligible.

2. In the cases in which petrositis is suspected, one cannot always be certain that an abscess of the brain has been excluded. Drainage of spinal fluid, particularly if the abscess is situated in the cerebellum, may be followed by disastrous results.

3. Ventricular puncture may give a clue as to the presence of a cerebral abscess. Evidence of a dilated or displaced ventricle should make one suspicious of an expanding or obstructing cerebral lesion.

4. In doubtful cases, in which exploration has failed to prove the presence of petrous suppuration, subsequent ventriculography can be performed with ease through an already existing trephine opening.

The proposal made in this communication is necessarily of a preliminary character and awaits further trial. Whatever information is available from others who may believe the method worth a trial will be most welcome.

ACOUSTIC STIMULATION OF INNER EAR BY APPLICATON OF SOUND INTO CAVITY OF MIDDLE EAR

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An appropriate application of a reliable indicator of hearing in experiments on animals has enabled us to obtain important information on the physiopathologic functions of the ear. We have used the reflex of the muscle of the middle ear in otologic research on both animals and man for a considerable time.

In this paper the problem of conduction and application of sound has been approached by means of experiments on animals. Our procedure developed from experiments on the labyrinthine pressure,[1] in which the following method was used:

A tube was inserted into the outer acoustic meatus of a rabbit and made air-tight. A second tube was fixed into the middle ear, and this opening was also firmly closed. Both tubes were connected with a syringe in which changes in pressure could be produced. A second connection was made with a manometer, by means of which the pressures were measured. The inner ear of the animal was opened, and a tiny glass capillary was inserted. By the optical system described in the former paper [1] the meniscus was visualized on a screen. Movements of the meniscus due to changes in pressure in either the middle or the outer ear could be observed fairly accurately.

The chart in figure 1 records the readings for the displacement of the labyrinthine fluid due to various positive and negative pressures in both the outer and the middle ear. The result was striking in that changes in pressure in the middle ear produced a far greater movement of labyrinthine fluid than similar changes in the outer ear.

The result of this experiment led us to try a similar procedure using sound waves. In other words, if the labyrinth apparently is so sensitive to changes in static pressure exerted in the middle ear, it might be as sensitive to changes in dynamic pressure in the cavity of the middle ear.

From the Department of Surgery, the University of Chicago. The work was done in part under a grant from the Douglas Smith Foundation for Medical Research.

1. Kobrak, Heinrich: Influence of the Middle Ear on Labyrinthine Pressure, Arch. Otolaryng. **21**:547 (May) 1935.

Rabbits were used for the experiment. Rubber tubes were inserted in the outer acoustic canal and in the middle ear in the same way as in the earlier experiment. The tubes formed a Y leading to a glass funnel, which was placed in front of a loud-speaker, thus collecting the sound energy from the sound-producer. By clamping the tubes the application of the sound could be interrupted entirely or confined either to the outer acoustic meatus or to the middle ear. The effect on the hearing ability of the animal was determined by the acoustic reflex contractions of the tensor tympani muscle. The value of the tensor reflex as an indicator of hearing in experiments on animals has been discussed in a former paper.[2] Here it may only be mentioned that the minimum intensity of sound which produced a visible contraction of the tensor tympani muscle was determined. These readings for the threshold of contraction for different pitches were plotted in the form

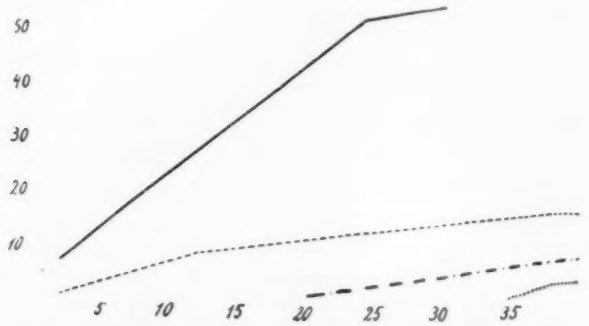

Fig. 1.—Chart showing the displacement of the labyrinthine fluid due to changes in pressure in the outer and middle ear of the rabbit. The abscissas represent the changes in pressure expressed in millimeters of mercury; the ordinates, the readings expressed in millimeters of the movements of the meniscus of the capillary connected with the labyrinth after optical enlargement on a screen. The line of dots indicates the changes in positive pressure in the outer acoustic canal; the line of dots and dashes, the changes in negative pressure in the outer acoustic canal; the line of short dashes, the changes in positive pressure in the middle ear, and the solid line, the changes in negative pressure in the middle ear. Changes in pressure in the middle ear produce greater displacements of the labyrinthine fluid than equivalent changes in pressure in the outer acoustic meatus.

of a curve. Figure 2 shows the curves obtained for hearing. As the curve shows, the hearing is increased considerably by application into the middle ear. In other words, the irritation of the labyrinth is

2. Kobrak, H.; Lindsay, J. R., and Perlman, H. B.: Value of the Reflex Contraction of the Muscles of the Middle Ear As an Indicator of Hearing, Arch. Otolaryng. **21**:663 (June) 1935.

definitely greater when the sound is conducted directly into the middle ear. This is similar to the effect of changes in static pressure, as shown in figure 1.

The quantitative estimation of the effect has been carried out in the same way as in the earlier experiments, namely, with a Western Electric 2-A audiometer with an amplifier and a loud-speaker. Readings were taken on the tensor tympani muscle of the opposite ear. Since tones of low pitch are conducted almost entirely through the tubes, clamping of the main tube abolishes the reflex. Tones of high frequency, however, cannot be confined to the tubes with this arrangement and therefore could not be used satisfactorily. The routine execution of these experiments was as follows: For each pitch four different readings

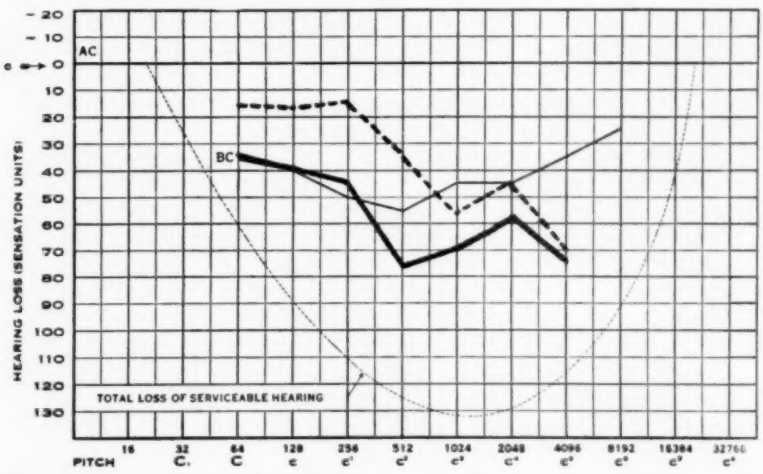

Fig. 2.—Chart showing the thresholds of the tensor reflex of the rabbit for sound carried directly into the outer acoustic meatus (indicated by solid line) and for sound carried directly into the middle ear (indicated by a dotted line). The "hearing gain" is obtained by application of sound to the middle ear.

were obtained (table 1). In column 1 in table 1 are recorded readings taken while the main tube was clamped. By this procedure a quantitative estimation of the intensity of sound which travels directly and thus reaches the ear without use of the tube could be carried out. As the table shows, tones of high pitch produce the reflex at about the same intensity when the main tube is unclamped as when it is not; on the other hand, conduction of tones of low pitch through the tubes is much more effective.

In column 2 are recorded the readings taken by application of sound into the outer ear. In this case the readings correspond essentially to those for normal hearing for a great number of rabbits which were observed for other purposes.

In column 3 are given the readings taken by application of sound to the middle ear. The result is striking. With the clamp removed from the rubber tube which leads to the cavity of the middle ear, the contraction of the tensor muscle is far greater. The difference of threshold varies according to the pitch. In order to obtain the new threshold the dial of the audiometer has to be turned down 25 or 30 or even 40 points.

In column 4 are given the readings for hearing by double application, that is, by conduction of sound into both the middle and the outer ear. Under these conditions, a further small gain was obtained in the majority of our experiments. However, we also observed cases in which hearing by double application was only equal to or was even less than that for simple sound conduction into the middle ear.

Attention has been given to the avoidance of any source of error due to the application of sound by means of tubes. The first and most

TABLE 1.—*Audiometer Readings for the Threshold of the Tensor Reflex for Tones of Various Frequency*

	1	2	3	4
Frequency of Tone	Clamping of Main Tube	Conduction of Sound to Outer Ear	Conduction of Sound to Middle Ear	Conduction of Sound Simultaneously to Outer and Middle Ear
64	..	34	17	17
128	60	40	17	15
256	64	45	17	16
512	79	78	37	37
1,024	67	70	56	56
2,048	57	57	47	47
4,096	73	73	70	70

simple procedure, of course, was to exchange the tubes, so that the former applicator to the middle ear became the tube for the outer ear, and vice versa. The material, the diameter and the length of the tubes were made as equal as possible. However, from the tests it was revealed that small differences in the length or in the diameter are of negligible importance. Bending the tubes and even formation of loops did not change the effect. Important, however, is the fact that the diameter of the tube was not reduced to less than a certain size and that the insertion of the tubes in the cavity of the middle ear was rather tight. The outer acoustic canal was always cleansed before the experiment, and a second test was always made immediately after the readings. This final test consisted of instillation of fluid into the bulla while a perforation was made in the ear drum. If the water ran out freely the outer canal was proved to be free from obstruction or kinking.

After this experiment had been tried on several animals with similar results, experiments were started in order to obtain information on

the underlying reasons for this phenomenon. Two questions were raised: Where does the sound enter the labyrinth? Why does sound introduced into the middle ear produce a better response than sound conducted from the outer ear?

With regard to the point of entrance, it was apparent that the sound waves may enter through either window. No attempt was made to determine whether a direct passage through the promontory takes place.

The rôle of the round window was investigated in experiments in which the niche of the round window was plugged by means of a small pledget of wet cotton.

Figure 3 shows the gain in hearing by application to the middle ear. Immediately after the readings were taken, a small piece of wet cotton

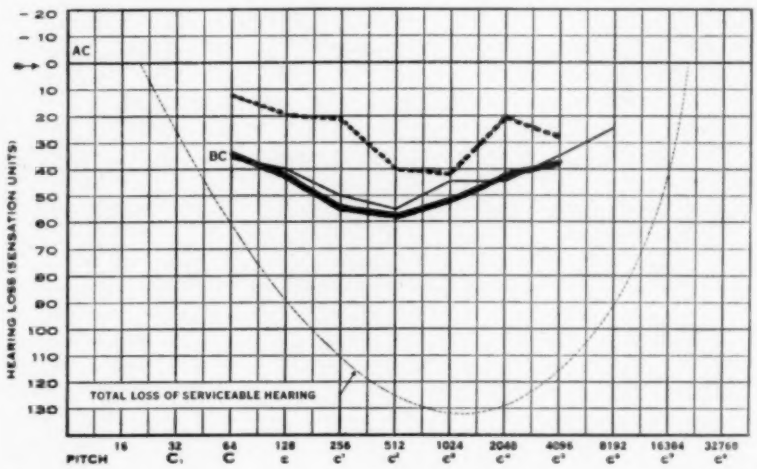

Fig. 3.—Chart showing the thresholds of the tensor reflex before the niche of the round window was plugged. The solid line indicates the threshold for sound carried directly into the outer acoustic meatus, and the broken line, that for sound carried directly into the middle ear.

was placed in the niche of the round window, and new readings were taken. The results obtained are shown in figure 4. By comparing the dotted and the solid line in the two diagrams, one can see that the "hearing gain" by application to the middle ear was diminished after the plugging, while, on the other hand, the hearing by way of the outer ear was practically unchanged. We do not assume that the cotton plug seals the round window completely. Therefore, we are not able to draw conclusions from the quantitative results. However, it is definite that by more or less complete occlusion of the niche of the round window the acoustic irritability of the labyrinth is diminished for the sound applied to the middle ear directly.

With the results of experiments with plugs placed in the round window another effect should be mentioned which was produced by nature. A rabbit which was tested failed to show the characteristic hearing gain by application to the middle ear. The readings are given in table 2.

This result was explained only after careful examination of the middle ear. It was then shown that the niche of the round window

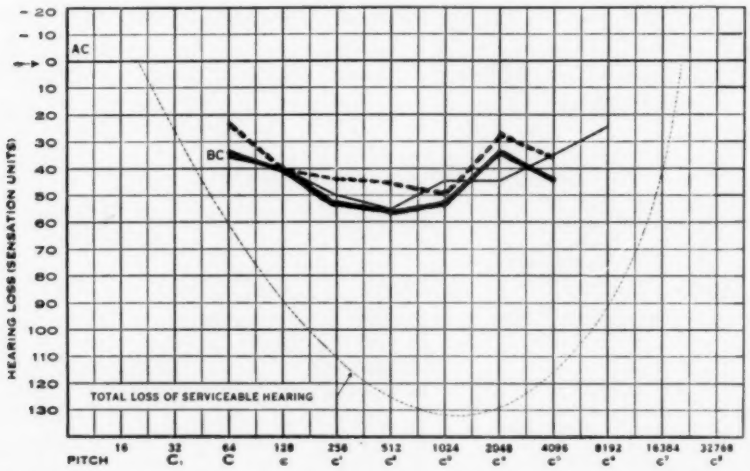

Fig. 4.—Chart showing the thresholds of hearing after the niche of the round window was plugged. The usual "hearing gain" by application to the middle ear is diminished. The hearing by application to the outer ear is almost unchanged. The solid line indicates the threshold of the tensor reflex for sound carried directly into the outer canal; the dotted line, the threshold for sound carried directly into the middle ear.

TABLE 2.—*Readings for the Threshold of the Tensor Reflex for a Rabbit in Which the Round Window of the Ears Was Plugged*

Frequency of tone	256	512	1,024
Application to the outer ear	53	52	85
Application to the middle ear	52	52	90

was apparently filled with material. The histologic picture is shown in figure 5. While the whole cavity of the bulla was grossly free from pus, there was a residue of suppurative material in the region of the window. The niche was plugged rather tightly. On comparison of the result in this experiment with that of the experiment shown in figure 4 one may assume that complete plugging of the niche is accompanied by complete loss of the "hearing gain," whereas a loose plug may produce only a partial loss. Similar evidence on this problem has been obtained

by experiments with cats, which furnish much better anatomic conditions for surgical intervention on the niche of the round window.

Other experiments were carried out by intervention on the middle ear mechanism. Artificial perforation of the ear drum was first tried, but the results were much less definite than when a break in the ossicular chain was produced. When the bulla ossea of the rabbit is opened on its ventral side, one has a good view of the ossicular chain and especially of the incudostapedial junction. Therefore, experiments were carried out in which this joint was destroyed and the incus luxated

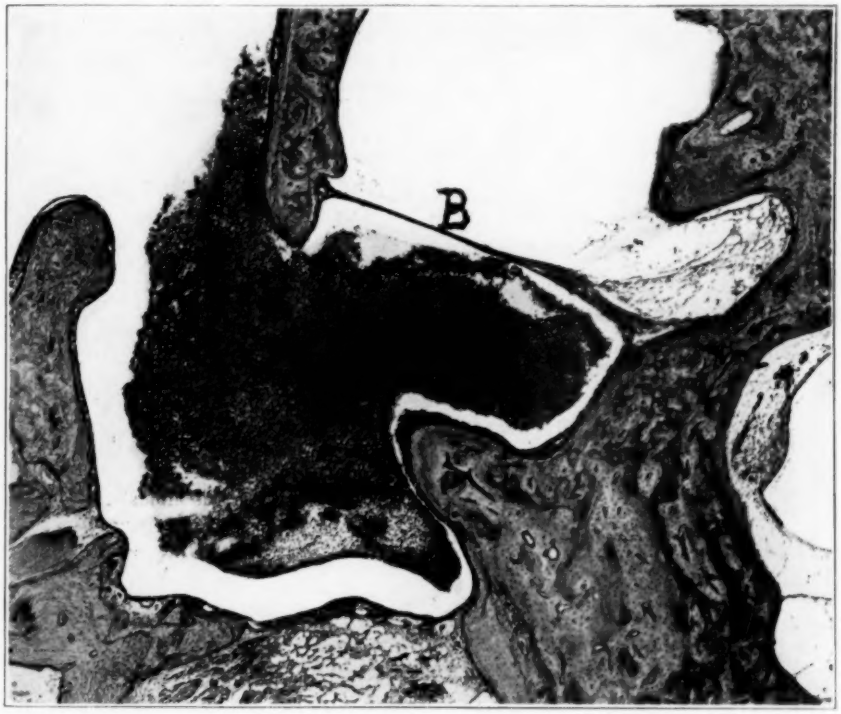

Fig. 5.—Section of the middle ear, showing the niche of the round window plugged by pus, accidentally observed in a rabbit which failed to show the typical hearing gain on application of sound to the middle ear. *A* indicates the accumulation of pus in the niche of the round window, and *B*, the membrane of the round window and the scala tympani.

or even extirpated. In contradistinction to the lesions of the ear drum the destruction of the incus may be carried out without hemorrhage. The result of one of these experiments is shown in figure 6. In figure 7 the histologic conditions are shown. The stapes as well as the round window shows no intervention, whereas fragments of ossicles can be seen displaced from the normal position. After the incus has been lux-

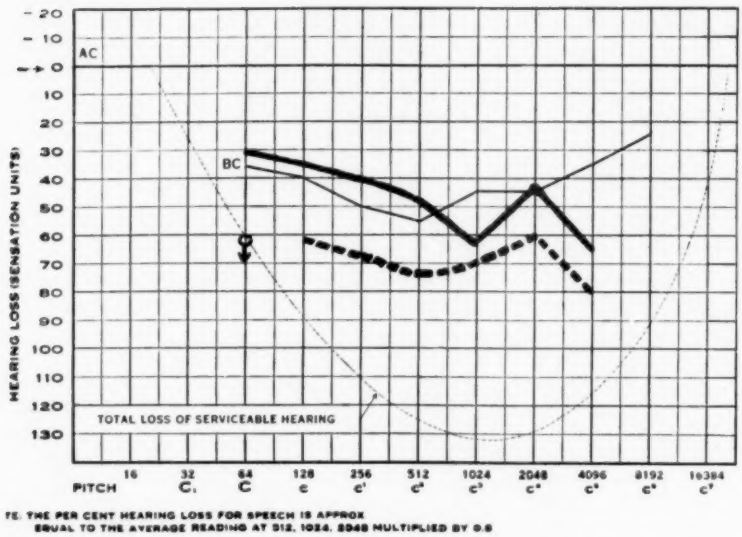

Fig. 6.—Curves showing (indicated by a solid line) the threshold of the tensor reflex for sound carried directly to a healthy middle ear and that for sound carried to a middle ear with a destroyed ossicular chain (broken line).

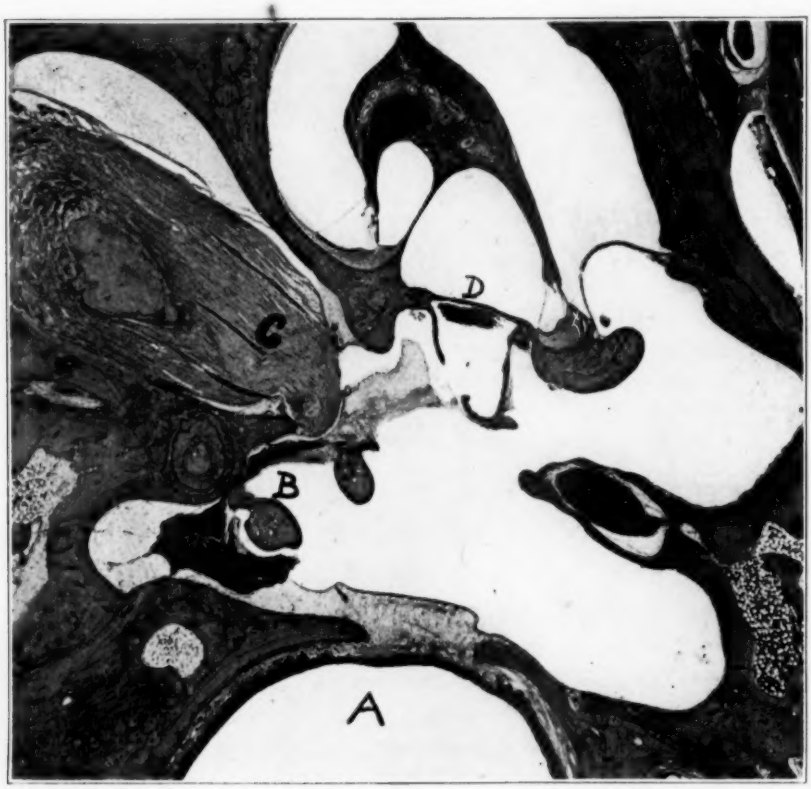

Fig. 7.—Section of the middle ear of a rabbit in which the ossicular chain had been destroyed. *A* indicates the outer acoustic canal; *B*, the parts of the ossicles; *C*, the tensor tympani muscle, and *D*, the foot-plate of the stapes.

ated, there is marked decrease in the hearing by application of sound to the middle ear. The tensor muscle is kinked and is still in contact with its bony attachment. From these experiments the assumption is made that an intact ossicular chain is essential for hearing gain by application of sound to the middle ear.

A possible interpretation of the findings is as follows: When the sound is applied directly into the cavity of the middle ear, the round window is at least an important, if not the only, point of entrance for the sound waves. From the anatomic standpoint it may be assumed that the organ of Corti is irritable from the region of the scala tympani, since the scala tympani borders on the basilar membrane. However, this anatomic relation hardly explains quantitatively the observed differences in the irritation of the cochlea. Another explanation was sought which at the same time would explain why the destruction of the ossicular chain diminishes the strength of the phenomenon. If the pressure is increased in the middle ear (both the positive static pressure and the positive phase of a sound wave), the round window bulges toward the scala tympani. At the same time the positive pressure in the middle ear presses the ear drum outward. The membrana tympani, owing to its greater diameter, pulls the chain, including the stapes, outward. In other words, a movement of the stapes in opposition to that of the round window is produced. This action is synergistic, resulting in greater movement of the perilymph and increased stimulation of the end-organ. This action would also explain why the removal of the incus or the destruction of the incudostapedial junction destroys the phenomenon.

SUMMARY

Changes in static pressure in the middle ear produce a greater displacement of the labyrinthine fluid than the same amount of pressure applied in the outer acoustic canal.

Changes in dynamic pressure in the middle ear (sound waves) have been investigated in respect to this effect.

In rabbits the hearing ability, measured by the strength of the reflex of the tensor tympani muscle, is greater when the sound is introduced directly into the middle ear than when it is applied from the outer acoustic meatus.

The increase in the irritation of the cochlea by application to the tympanum (or by aerocochlear conduction) is diminished or abolished when the round window is plugged. The increase is also diminished by lesions of the ossicular chain.

An interpretation for these findings is suggested.

HISTOLOGIC VARIATIONS IN THE MIDDLE AND INNER EARS OF PATIENTS WITH NORMAL HEARING

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One important objective of the work of this laboratory is the interpretation of the various clinical tests of hearing. After examining a patient with impaired hearing the otologist should be able to correlate the patient's history and the findings at examination with the results of tests with the audiometer and with tuning forks and conclude with a considerable degree of accuracy what particular structure or structures in the middle or inner ear are involved in the lesion. The present and rather crude interpretation of the results of tests of hearing is based on correlations of clinical observation, results of functional tests and the histologic appearance of the various structures in the middle and inner ear; the pioneers in this type of work were Bezold, Siebenmann and Politzer. During the past ten years intensive studies of this type have been in progress in this laboratory; the temporal bones from more than 2,000 patients have been removed at autopsy and sectioned serially. In about one half of the cases the hearing had been carefully tested before death. Since the plan of my associates and me is to test the hearing of all patients whose general condition (arteriosclerosis, nephritis, tuberculosis, etc.) suggests that they will soon come to autopsy, we necessarily find among our material many records of perfectly normal hearing. If the histologic picture of the middle and inner ear is to be correlated with the results of the hearing tests, obviously the histologic observations carried out on these patients with normal hearing is an important part of the study, and the patients constitute a control group for comparison with those with the changes associated with impaired hearing.

All the patients in the group reported on in this paper had normal hearing. By this I mean that the acuity for all tones was above 20 sensation units; the results of tuning fork tests were normal, and there was no history or symptoms of any aural disturbance. Either the 1-A or the 2-A Western Electric audiometer was used in making the tests. The number of patients was small, because for such a correlation study (1) the results of the functional tests must be accurate and complete, (2) the interval of time between the test and removal of the temporal

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bones at autopsy must be short and, of equal importance, (3) the preservation of the various structures in the temporal bone must be good, as false conclusions result if histologic artefacts are mistaken for organic lesions. Owing to these restrictions only sixty-three ears (thirty-eight patients) are included in this group. The ages of the patients varied from 10 to 65 years and were fairly evenly distributed through the decades from 10 to 50. In one half of this group the interval between the hearing test and the removal of the temporal bones at autopsy was less than thirty days; for the remaining half the average time was three months.

When the audiometer and tuning fork tests were made all the patients were questioned regarding present or past aural disorders. We were forced to conclude that the patients' memory of aural infections in the past was often not accurate, since healed perforations, fibrous thickening or deposits of calcium in the tympanic membrane or a marked retraction was often noted when the history of aural disorders of any kind was negative. A definite history of otitis media was obtained for only six of the thirty-eight patients, and it is interesting to note that in these six the pathologic changes in the sections of the middle ear were less than in those with no history of any aural infection.

All the patients whose temporal bones were used in this study were tested with the audiometer, tuning forks and the monochord, and most of them were given a caloric vestibular test. In every one of these thirty-eight patients air conduction was better than bone conduction. In three cases it was recorded that the bone conduction time for the 512 double vibration fork was shortened five seconds or less, which we consider within the range of normal variation. The results of the Weber test were normal in twenty-six of the thirty-eight patients, and of the twelve who did lateralize the sound it was referred to the right ear by six and to the left ear by the remaining six. We were unable to note definite pathologic changes in the sections of the middle and inner ears that would explain the lateralization in the Weber test. Such histologic changes as were observed in the ears of these patients must be considered as variations of the normal and of no functional significance. As a rule, these changes were present on both sides, and frequently when they were more marked on one side the records showed that the tone was referred to the more normal of the two ears. Our experience suggests that the histologic changes illustrated in the figures are variations of the normal and are of no functional significance and that the Weber test is too subjective to be reliable and the results of this test should not be given too much consideration if they fail to agree with the results of other and more objective methods of testing the hearing.

A caloric vestibular test was not made in all cases, but with one exception the response was normal in every ear tested. This one excep-

tion was the right ear of a patient, aged 41 years, who gave no history of vertigo or other vestibular disorder. The response of the opposite ear was normal. We were unable to observe any lesion in the histologic sections of the affected ear that would explain the lack of response.

Fig. 1.—Section through the temporal bone of a patient with normal hearing. The tympanic membrane has an extreme degree of calcification. The jugular bulb is very high. There is slight thickening of the mucous membrane in the region of the attic.

HISTOLOGIC CHANGES

The appearance of the tympanic membrane varies greatly in persons with normal hearing. About 40 per cent of the patients in this study showed pathologic variations in the drum. One third of the thirty-eight patients had changes in Shrapnell's membrane, and in about half variations from the normal were seen in the pars tensa. The extent of the

pathologic changes varied from slight thickening to marked calcification (fig. 1) and from moderate to extreme retraction with the drum adherent to the promontory (fig. 2).

The region of the oval window and the niche of the round window were seldom free from remaining strands of embryonic tissue. In only

Fig. 2.—Section through the temporal bone of a patient with normal hearing. The drum is extremely retracted and adherent to the mucous membrane over the promontory. The jugular bulb is high. The niche of the round window is filled with cystic embryonic tissue which is adherent to the membrane of the round window. The mucous membrane covering the promontory is thicker than normal.

about one fifth of the cases were these areas clear. Sometimes the strands of tissue extending from the lateral walls of the fossula to the anterior or posterior crus in the oval window were small and delicate, while in others they were broad and more fibrous (fig. 3). In one patient, a 21 year old man with normal hearing for all tones, there was

an extensive area of otosclerosis. The otosclerosis involved the labyrinthine capsule around the oval window, but the annular ligament was not affected (fig. 4). The normal hearing of this patient was due to the fact that there was no interference in the movement of the stapes. In patients with normal hearing we have found that the annular ligament was invariably normal. In the niche of the round window, strands of tissue similar to those in the fossula of the oval window were seen in many of the sections. The strands of tissue in this location, however, were usually more fibrous and were attached to the secondary tympanic

Fig. 3.—Section through the oval window of the temporal bone of a patient with normal hearing. The section shows the anterior part of the footplate of the stapes, with the anterior crus attached to the promontory by a wide band of mucous membrane.

membrane, or the membrane of the round window. The amount of this tissue was usually greater in the niche of the round window than in the fossula of the oval window. Its presence in both regions may have been due to incomplete absorption of the mesenchymal tissue which fills the middle ear during fetal life or to a previous infection (fig. 2).

An abnormal degree of thickening of the mucous membrane over the region of the promontory was present in sixteen of the sixty-three ears of this group (fig. 2). Thickened mucous membrane in this region is probably the result of old infections.

Fig. 4.—Section through the anterior part of the oval window of a man, 21 years old, who had normal hearing. One can see the anterior tip of the footplate of the stapes, surrounded by the annular ligament. The bony part that is just anterior to the oval window contains a large area of otosclerosis. The growth of the otosclerosis has not involved the annular ligament or caused any limitation in the movement of the stapes.

Fig. 5.—Section through the malleus and incus of a patient with normal hearing. The incus contains a large space that is filled with fibrous tissue; there is only a thin cortical layer of bone. The incus in this illustration can be compared with the one in figure 6.

It is striking that the following regions of the middle ear were usually free from pathologic changes: the epitympanic recess, the anterosuperior part near the entrance of the eustachian tube and the

Fig. 6.—Section from the same temporal bone as that in figure 2. Heavy bands of remaining embryonic tissue are attached to the crus of the stapes and lateral wall. There is a marked deformity of the incudostapedial joint. The drum is retracted. The jugular bulb is high.

hypotympanic region. These areas were involved in only 10 per cent of the cases and then only to a slight degree. In this group of sixty-three ears with known normal hearing the head of the malleus and incus was always seen to be free from adhesions or anything that would interfere with their motion. The histologic variation in the structure of the malleus and incus is always interesting. In some cases the bone was dense, and there were few marrow spaces. In others there were large marrow spaces with a thin bony cortex (fig. 5). These variations have no effect on the acuity of hearing of the patient.

One of the most interesting cases in this study is that of a white girl, aged 17 years.

The patient came to the hospital because of malnutrition, cough and fever. At the age of 5 years she had infantile paralysis and following this convergent strabismus. Physical examination revealed advanced pulmonary tuberculosis. The patient had always thought her hearing good. She had no aural disorder, earache, discharge or tinnitus. The results of the hearing test were interesting in that the hearing in the left ear was normal, but there was a total loss of hearing on the right. In the Weber test the sound was referred to the left ear. Air conduction was greater than bone conduction on the left. None of the tuning forks was heard in the right ear when the left ear was masked. The audiogram showed normal hearing for the left ear and total loss of hearing in the right ear when the left was masked. The sections of the temporal bone of the right ear revealed an obliterative labyrinthitis with complete destruction of the inner ear. In addition to the tests with masking, this made it even more certain that all the hearing that the patient had was in the left ear. The sections of the left temporal bone were of unusual interest on account of the marked pathologic changes in an ear with normal hearing. The tympanic membrane was thickened and retracted. The retraction was of such a degree that the pars tensa had become adherent to the mucous membrane covering the promontory (fig. 2). The tissue overlying the promontory was also thickened, especially in the region posterior to that shown in figure 2. In the hypotympanum there were remains of cystic mesenchymal tissue. The jugular bulb was high and the niche of the round window very narrow (fig. 2). The niche of the round window was filled with cystic, embryonic-like tissue which was adherent to the secondary tympanic membrane (fig. 2). The crura of the stapes were embedded in the same type of tissue (fig. 6). The head of the malleus, however, was free from adhesions and looked normal.

The histologic picture of the inner ear in patients with normal hearing was studied thoroughly when the observations on the control group reported in the paper published in 1934 [1] were being made. A detailed reconstruction of the cochlear structures was made for every case in this group. Partial atrophy of the nerve, end-organ and cells of the external sulcus was frequently noted, but in every case these changes were limited to the extreme lower part of the basal turn. Similar changes

1. Crowe, S. J.: Guild, S. R., and Polvogt, L. M.: Observations on the Pathology of High-Tone Deafness, Bull. Johns Hopkins Hosp. **54**:315 (May) 1934.

in the cochlea were observed in the sixty-three ears considered in this study. It is rather common to observe partial atrophy of the stria at almost any level of the cochlea, but this area of partial atrophy usually is very limited in extent.

SUMMARY

As the result of this study of sixty-three ears from patients who had a test of hearing shortly before death and whose hearing was found to be normal, it is certain that marked pathologic changes of the tympanic membrane may exist without causing any noticeable impairment of the hearing.

Bands of embryonic or fibrous tissue in the niche of the round window and the fossa of the oval window may have no effect on the acuity of hearing. It is assumed that they do not interfere with the movements of the stapes.

The regions of the middle ear that usually were noted to be free from any pathologic changes were: the epitympanic recess (nothing to interfere with the movements of the head of the malleus and incus), the anterosuperior part (nothing to interfere with the normal functioning of the eustachian tube) and the hypotympanic region. The annular ligament was normal in all the cases.

With the exception of a partial atrophy of the nerve, the organ of Corti and the cells of the internal sulcus in the last millimeter of the basal coil of the cochlea, the inner ear was normal in each of these sixty-three ears. It is common to observe atrophy of the stria over short distances of any level of the cochlea, and it is certain that these limited areas of strial atrophy are of no functional significance.

HISTOLOGIC CHANGES IN THE TEMPORAL BONE IN OSTEITIS DEFORMANS (PAGET'S DISEASE)

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Osteitis deformans (Paget's disease) is a chronic disease which begins in middle life or later. Its progress is slow and may continue for many years, causing only such trouble as arises from deformity in the affected bones. According to Schmorl,[1] the sacrum and the lumbar vertebrae are most commonly affected, and the long bones of the extremities and the bones of the skull are rather frequently involved. The diseased bones are enlarged, and those bearing weight become curved; the skull becomes large and misshapen, the increase in thickness taking place almost entirely outward, so that the inner table remains unaltered. The frontal sinus is at first little changed, though it may become smaller in an advanced stage. The base of the skull is often involved, so that the pituitary fossa may be altered, and the petrous part of the temporal bone may show distinct signs of the disease. It is with the petrous part of the temporal bone that we are now concerned.

Although the literature on pathologic changes of bone contains a large number of papers which describe the changes in cases of osteitis deformans, few deal with the effect of the disease on the petrous portion of the temporal bone. Owing to the fact that this bone contains osseous tissue of unusual types, a consideration of its alteration in Paget's disease may be of interest; moreover, a description of the histologic changes as evidenced in our specimens may not be without value.

In Butlin's addendum to the original paper by Sir James Paget[2] certain of the histologically peculiar characteristics of osteitic bone were briefly described. It was recognized that the extensive resorption of bone is everywhere accompanied by a new formation; the latter change

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From the Departments of Otolaryngology and Anatomy, Northwestern University Medical School; contribution no. 218 from the Department of Anatomy. This investigation was conducted under the auspices of the Central Bureau of Research of the American Otological Society.

1. Schmorl, G.: Zur Kenntnis der Ostitis fibrosa, Verhandl. d. deutsch. path. Gesellsch. **21**:71, 1926; Zur Kenntnis der Ostitis deformans Paget, ibid. **25**:205, 1930; Ueber ostitis deformans Paget, Virchows Arch. f. path. Anat. **283**: 694, 1932.

2. Paget, James: On a Form of Chronic Inflammation of Bones (Osteitis Deformans), Med.-Chir. Tr., London **60**:37, 1877.

occurs in such a manner that not only is the total thickness of the altered bone increased but its texture assumes a much more spongiose appearance than that of the tissues which it replaced.

Subsequent accounts, by Clutton [3] (1888) and others, established definitely the clinical aspects of the disease; the various authors also emphasized the gross changes seen at autopsy, pointing out that the bones become progressively larger and longer while concurrently becoming softer and that the characteristic skeletal deformities were dependent on the substitution of cancellous for compact bone.

A full account of the special histologic changes of the osteitic process was the product of much more recent studies. Thus, Dawson and Struthers [4] (1923), in a contribution dealing chiefly with Recklinghausen's disease, described in detail the processes of destruction and of new formation of osseous tissue not only in diseases of the bones generally, including Paget's disease, but on a comparative basis the corresponding steps in the development of normal bone. These authors reviewed the stages in the formation of bone—metaplastic and appositional—and the mechanisms accounting for its destruction—lacunar resorption, halisteresis and vascularization. Such concurrent destruction and repair in Paget's disease produce a distinguishing histologic feature, as pointed out by Schmorl [1] (1926, 1930, 1932), namely, the mosaic architecture of the bone, so characteristic as to be of diagnostic value (1932), a feature emphasized independently by Knaggs [5] (1925), who described the bone as "decorated with internal curvilinear markings." Later Freund [6] (1929) and Jaffe [7] (1933) were struck by the completeness with which the normal smooth lamellar arrangement is transformed into a mosaic pattern, made up of small fragments interlaid into a very irregular design. Jaffe noted that there is little or no tendency for the fragments to be disposed around vessels so as to form haversian systems; they are distinguished not only by their discontinuous lamellae but also by the presence between neighboring pieces of blue-staining "cement lines," wider than the lamellar lines.

It is evident from this brief review that the histologic features characteristic of osteitis deformans are well known and that their significance

3. Clutton, H. H.: A Case of Osteitis Deformans Showing a Want of Symmetry and Lengthening of Some of the Bones, Tr. Path. Soc. London **39**:259, 1888.

4. Dawson, J. W., and Struthers, J. W.: Generalized Osteitis Fibrosa, Edinburgh M. J. **30**:421, 1923.

5. Knaggs, R. L.: Osteitis Deformans (Paget's Disease) and Its Relation to Osteitis Fibrosa and Osteomalacia, Brit. J. Surg. **13**:206, 1925.

6. Freund, E.: Zur Frage der Ostitis deformans Paget, Virchows Arch. f. path. Anat. **274**:1, 1929.

7. Jaffe, H. L.: Paget's Disease of Bone, Arch. Path. **15**:83 (Jan.) 1933.

is understood. In connection with our specimens we shall discuss these features more fully. We are of the opinion that we are justified in adding another paper to the literature on osteitis deformans for two reasons: first, because we have been able to study the disease in both temporal bones of the same subject, in one of which the process was active and in the other approaching a quiescent state, and, second, because the spread of the disease through the petrous part of the temporal bone offers special features for study. The changes within the temporal bone during the progress of osteitis deformans were described first by Otto Mayer in 1917 and later by others, the series being climaxed by the reports of Nager [8] and Meyer in 1933.

Our chief interest in the present program of investigation lies in the study of otosclerosis. It has been realized that although the histopathologic changes of this disease are well understood, little is definitely known about the pathogenesis, and the fact is equally apparent that a wide, inclusive concept of diseases of bone is essential to an understanding of the processes at work in any one of them, whether of the nutritional or of the inflammatory type.

It was natural that a study of a case of Paget's disease, a disorder of the irritative type and of slow progress, would suggest a relationship to another chronic disorder of the bone, namely, otosclerosis. While our study is in an early stage, it is evident that the designation osteodystrophia fibrosa, *eine auf die Labyrinthkapsel beschrankte* (Nager and Meyer), for otosclerosis is scarcely applicable and actually links it too closely with other diseases of bone which manifest a very different set of histologic changes; such inclusion can be of service only in reminding the otologist of the most generalized similarities in the histopathologic changes of bone and, like all attempts to classify disease, is useful if not pressed too far.

In a separate publication we propose to discuss other diseases of the temporal bone and shall limit the scope of the present paper to a consideration of osteitis deformans.

MATERIAL AND METHODS

Two temporal bones from a patient with Paget's disease were furnished by Dr. Samuel J. Kopetsky, of New York, and through him we were provided with the history of the case, the audiogram and the record of observations at autopsy (the autopsy report was prepared by Dr. Henry L. Jaffe).

The bones were decalcified in a dilute solution of nitric acid in formaldehyde, U. S. P. (1:10), and embedded in pyroxylin. Both temporal bones were sectioned in the horizontal plane at a thickness of 15 microns. The bone of the right side was prepared in the department of otolaryngology of the Northwestern

8. Nager, F. R.: Die pathologische Anatomie der Labyrinthkapsel und ihre klinische Bedeutung, Ztschr. f. Hals-, Nasen- u. Ohrenh. **34**:72, 1933.

University Medical School by Miss Helen Banks. In general this series of sections was stained with hematoxylin and eosin, Van Gieson's stain being employed for a limited number of selected sections. The temporal bone of the opposite side was similarly sectioned and stained under the supervision of Dr. T. H. Bast at the medical school of the University of Wisconsin. The sections of normal bone from a young and an old adult (figs. 1, 1*a* and 2) were already available in the otologic collection of the Northwestern University Medical School. From the two series of sections numerous tracings of typical microscopic fields were prepared with the Edinger projection apparatus (usually at a magnification of 345 diameters). From these tracings the most illustrative representations of the histologic changes were selected for drawings.

REPORT OF A CASE

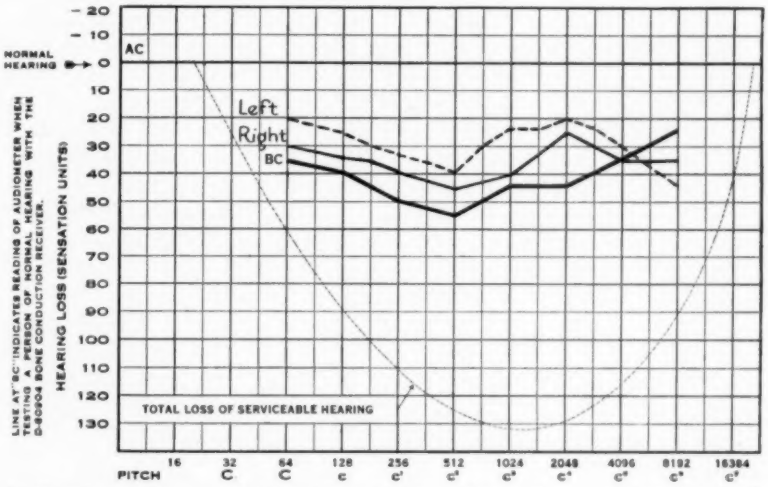
History and Course.—A Negro, aged 55, was admitted to the Hospital for Joint Diseases, New York, on July 25, 1932, with acute congestive heart failure. The first attack occurred in 1928; in May 1932 there was a severe attack of pain in the left side of the chest, which radiated to the left arm and back, making breathing difficult. This condition steadily became worse, and the patient was confined to bed from the time of onset in May until he was admitted to the hospital. There was a history of chronic cystitis and osteitis deformans; the patient said that he had not had a venereal disease.

When the patient was admitted to the hospital there was marked edema of the lower extremities from the ankles to the sacrum; coarse râles were heard, simulating those of acute pulmonary edema. A roentgenogram of the lungs made the day after the patient was admitted to the hospital showed cardiac hypertrophy and dilatation and congestive changes at the base of each lung. The plates included a view of the left shoulder, where changes typical of Paget's disease were noted at the margins of the scapula. A Wassermann test made the same day was negative. Treatment with diuretics brought some improvement. The edema in general diminished, although on August 3 the skin over the left cubital fossa began to slough, without, however, further extension of the process and without suppuration. A roentgenogram of the heart made on August 5 revealed great cardiac enlargement and, in the thoracic skeleton, the changes characteristic of Paget's disease; roentgenograms made a week later displayed extensive bony changes of the same nature, involving the skull, the pelvis, both femurs and tibias, the right humerus and the left ulna. In the shaft of the right tibia was an extremely large area of early destruction. During this period the patient showed general improvement in the pulse and respiration. On August 30 the values for urea and creatinine in the blood were at a normal level, showing a cessation of the chronic passive congestion of the kidneys. In spite of the fact that the Wassermann test was negative, it was considered that the cardiac lesion, there being continued cardiac enlargement and apparently aortic stenosis, was unquestionably of syphilitic origin.

On September 7 there was an increase in edema of both legs; four days later the patient complained of pain in the legs. There had been a gain in weight, but by September 16 a steady loss was occurring. Two weeks later pain was reported in the muscles on the back of the right thigh. On October 14 the patient was allowed to get out of bed, with no ill effect, but on October 17 edema was evident over the dorsum of the feet and in the pretibial region. By October 19 the patient was very weak; the blood pressure was low; the temperature was 100.6 F.; the pulse rate was 98, and the respiratory rate was 32. On the following day

the patient was severely dyspneic and orthopneic; the mucous membrane was cyanotic, and the extremities were cold, as if the patient were in a state of slight shock. The pupils were dilated; there was precordial pain; the heart rate was 100; the temperature was 103 F.; moist râles were heard over the entire area of the chest, and the pulse was small and thready. The picture was that of acute coronary occlusion and heart failure.

For a few succeeding days the patient improved, but on October 26 marked edema of the feet occurred, and by October 31 had increased. The audiogram given here was made on October 29. On November 3 the following vessels were without pulsation: the radial and the brachial veins on both the right and the left side in their distal portions and all arteries of the lower extremities up to the proximal third of the thighs. On the succeeding day there occurred a sudden rise in temperature to 103.2 F. and an attack of coronary occlusion with cardiac



Audiogram made on October 29, showing observations on hearing in both ears. A reading for bone conduction of A_1, C_2 showed the time to be moderately shortened.

failure; the patient was dyspneic; his lips were cyanotic, and he complained of pain in the right shoulder. He died on November 5.

Autopsy.[9]—The patient was fairly well developed and 5 feet, 6 inches (167.6 cm.) tall. General examination revealed no abnormality except an outward rotation of the left lower extremity and some edema about the ankles; there was no hypostatic congestion or edema over the back; the chest was moderately emphysematous.

The abdomen did not contain free fluid; there were no abnormalities other than fibrous adhesions at the foramen of Winslow and between the gallbladder and the left colic flexure. The spleen was slightly enlarged. The pleural and pericardial cavities did not contain excess fluid; the lower lobe of each lung was adherent, especially posteriorly. The heart was enlarged to almost twice the

9. This report is condensed from the notes on the autopsy (performed on Nov. 5, 1932) from the department of pathology of the Hospital for Joint Diseases (Dr. Henry L. Jaffe, director of the pathologic laboratories).

normal size and extended for a considerable distance into the left side of the chest. All the chambers were markedly dilated, and the wall of the left ventricle was considerably thickened, as were the trabeculae and the papillary muscles. The aortic semilunar valves were markedly thickened and somewhat shortened; they were extremely firm (apparently calcareous) and studded with numerous nodules. The lumen of the aortic orifice was almost completely obstructed; the coronary vessels were thin-walled, smooth and patent. On section the lungs presented predominantly a reddish color, with no evidence of abnormalities. The gallbladder and ducts, the gastro-intestinal tract, the parenchyma of the adrenal glands, the pancreas and the kidneys appeared normal; the spleen seemed firmer than usual and was dark red when cut. The mucous membrane of the urinary bladder presented discrete areas of congestion and one or two areas of hemorrhage. The tongue and the thyroid and parathyroid glands did not show pathologic changes.

The lymph glands were normal in size and soft. The inner wall of the aorta was elevated into yellow patches, some of which were firm and brittle. In certain areas ulceration apparently occurred; there were none of the soft swellings or the scarrings characteristic of syphilis. The renal arteries contained faint yellowish areas in their internal layer; the left femoral and popliteal arteries displayed a process of thickening which in the latter vessel had progressed to the stage of complete occlusion. The brain, spinal cord and meninges were normal.

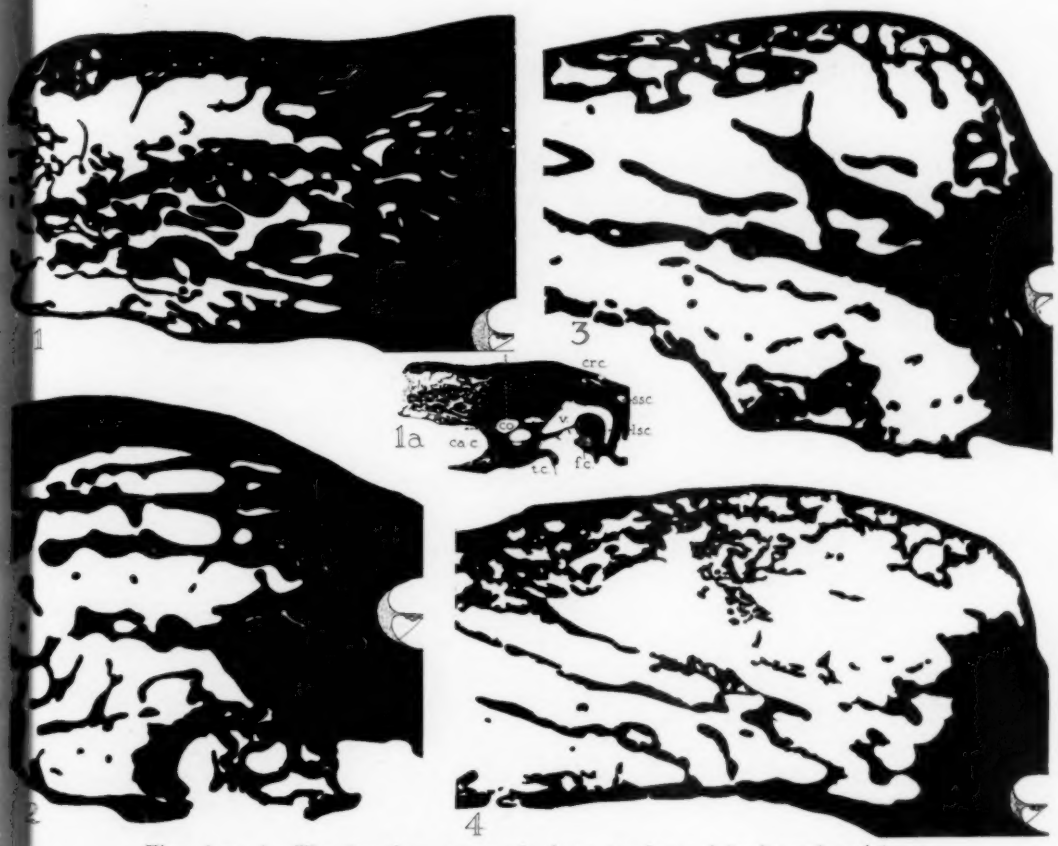
The bones were involved in a distinctly pathologic process. All the vertebrae displayed the spongiose formation which is characteristic of Paget's disease; the bones of the pelvis were also extensively involved. The sternum, the right humerus and scapula and some of the ribs were likewise converted into spongiose tissue. The left femur, both tibias and several bones of the left foot were affected similarly; the calvarial portions of the base of the skull and both temporal bones were partially involved. The calvarium reached its greatest thickness in the frontal region just above the frontal sinus, where it measured 15 mm. and where there was complete obliteration of the normal architecture of the bone, the cut appearance being more or less uniform and showing the typical pumice-like bone of Paget's disease.

The outstanding features of the anatomic diagnosis were: (1) cardiac hypertrophy and dilatation; (2) arteriosclerosis of the aorta, aortic valve, renal arteries and arteries of the lower extremities; (3) aortic stenosis; (4) chronic passive congestion of the viscera, and (5) disseminated Paget's disease of the skeleton.

OBSERVATIONS ON SPECIMENS

The pathologic changes in our specimens of temporal bone affected particularly the medial portion of the petrous part and can be most readily appreciated as to extent and effect by comparing these bones histologically with bones of normal structure.

Thus, in normal bones of adults of 57 (figs. 1 and 1*a*) and 18 years of age (fig. 2) the architectural pattern, when seen at low magnification, is one in which the trabeculae of the cancellous tissue are broad and smooth and when taken together are approximately as great in bulk as the marrow tissue enclosed by them; the inner table of bone is thick. In the osteitic bone from the 55 year old adult (figs. 3, 4 and 41) the pattern is, on the contrary, an open network: The trabeculae are slender, and the inner table is thin, especially in the bone of the left side, where



Figs. 1 to 4.—The drawings are made from tracings of horizontal serial sections prepared with the Edinger apparatus. The four fields are taken from the anterior part of the petrous portion of the temporal bone. Figures 1, 2, 3 and 4 are in a magnification of 5 diameters; figure 1*a* is natural size. Figure 1 is a section showing the normal architecture of that part of the petrous temporal bone which is situated just anterior to the cochlea. The marrow tissue is omitted. The patient was a man 57 years old. Figure 1*a* is a section through the petrous part of the temporal bone, showing the topographic location of the cancellous tissue at the petrous tip. The membranous structures of the labyrinth are omitted. The situation of the area shown in figure 1 is indicated. Figure 2 is a section showing the area of the temporal bone similar to that shown in figure 1 in a girl 18 years old. Figure 3 is a section showing the area, similar to that shown in the preceding figures, of a temporal bone of the right ear of a man 55 years old with Paget's disease, and figure 4 is a section of the similar area and at the same level in the ear of the bone on the opposite side. *Ca.c.* indicates the carotid canal; *co.*, the cochlea; *cr. c*, the cranial cavity; *f.c.*, the facial canal; *l.s.c.*, the lateral semicircular canal; *s.s.c.*, the superior semicircular canal; *t.c.*, the tympanic cavity, and *v.*, the vestibule.

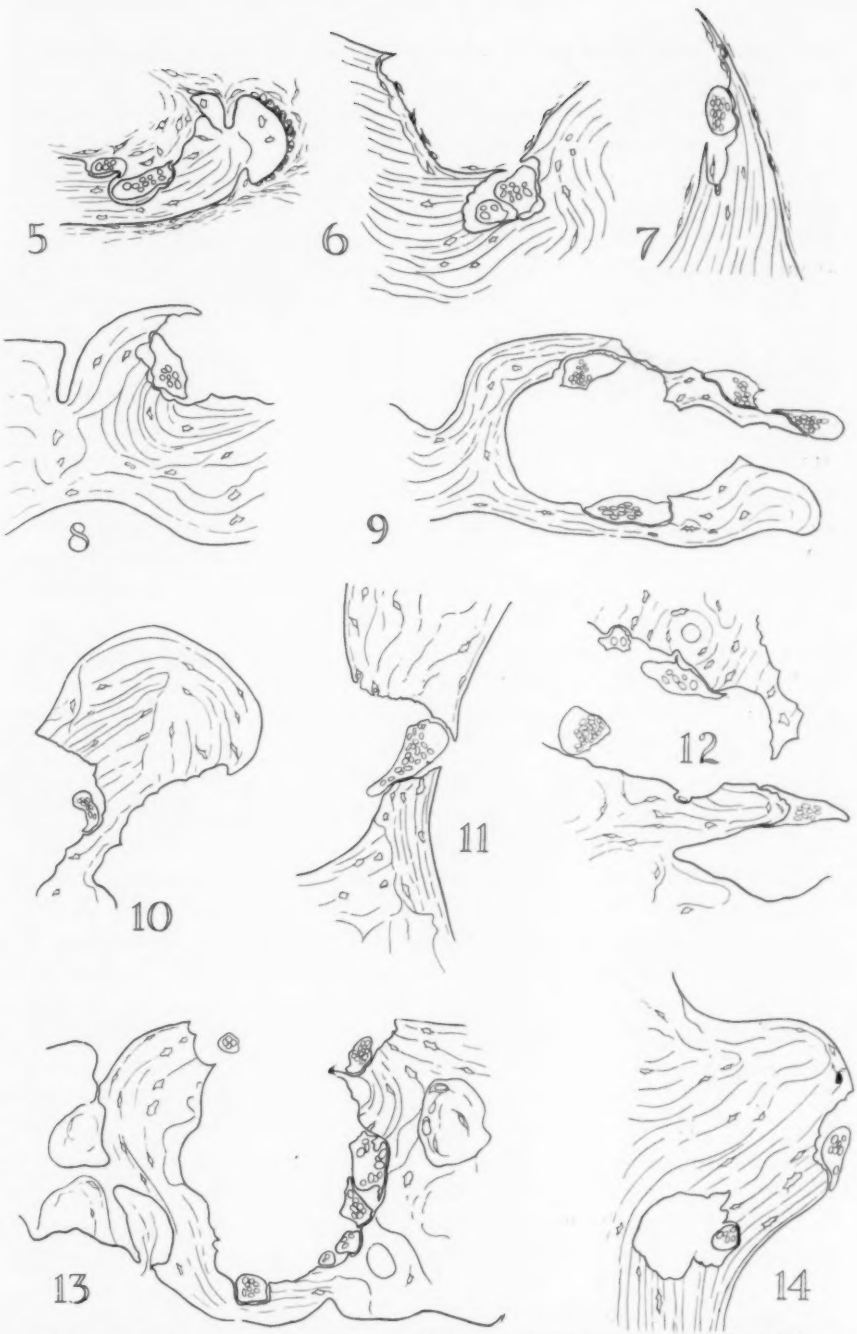
the disease was in the more active stage; the surface of the trabeculae are irregular (fig. 4).

In the normal bone, when examined at higher magnification, the systems of concentric haversian and intervening ground lamellae of the compact tables conform to the familiar pattern; likewise in the cancellated bone the lamellae follow uninterruptedly the long axes of the spicules; all the haversian canals are minute smooth-walled apertures containing only a few vessels and a small amount of supporting areolar tissue. In the diseased bone the canals are enlarged and eroded and often communicate freely with the surrounding marrow tissue. The marrow in the normal bone is fatty, but in the diseased bone formative blood cells predominate over fat. Briefly, then, in the normal bone the histologic picture is that of quiescence, and in the bone of Paget's disease it is one of activity.

This activity is expressed chiefly in the widespread destruction of osseous tissue; but secondarily there is a marked tendency toward the formation of new bone and the transformation of the delicate reticular structure of the adipose marrow into either hematopoietic tissue or tissue resembling productive periosteum.

Destruction is such an arresting feature of osteitic bone that the usual distinction between the peripheral and the deeper levels is lost; the bone is highly cancellous throughout (compare figs. 2 and 4). The inner table of the skull and the wall of the carotid canal remain merely as fine strata of periosteal lamellae from which even thinner trabeculae arise; in many of the sections the plates are interrupted by gaps which are seemingly enlarged Volkmann canals; these transmit blood vessels larger than the nutrient arteries ordinarily seen in the petrous temporal bone and are especially abundant in the area of the trigeminal impression.

Throughout each section in our extensive series (thirteen hundred sections) the exact nature of the rarefaction is readily evident: The concentric haversian lamellae and the regular ground lamellae are everywhere deeply eroded, their remnants persisting as jagged pieces or mere fragments. The jagged appearance of the spicules is due to the presence along their borders of many shallow pits placed side by side, which frequently constitute the crenated margins of more considerable excavations. The lesser pits, occupied in most instances by osteoclasts, are the lacunae or foveolae of Howship, which when merged form the larger excavations (figs. 7, 10, 13, 18 to 21 and 29). All stages in the process of destruction of bone are exhibited, from obviously initial stages in which interruption of the external lamellae has just begun (figs. 14, 16 and 18) to advanced stages in which the residual bone appears as if it had been cut across (figs. 11, 15, 19, 22, 24 and 27). Curious forms may be assumed by the irregular pieces: They are, for

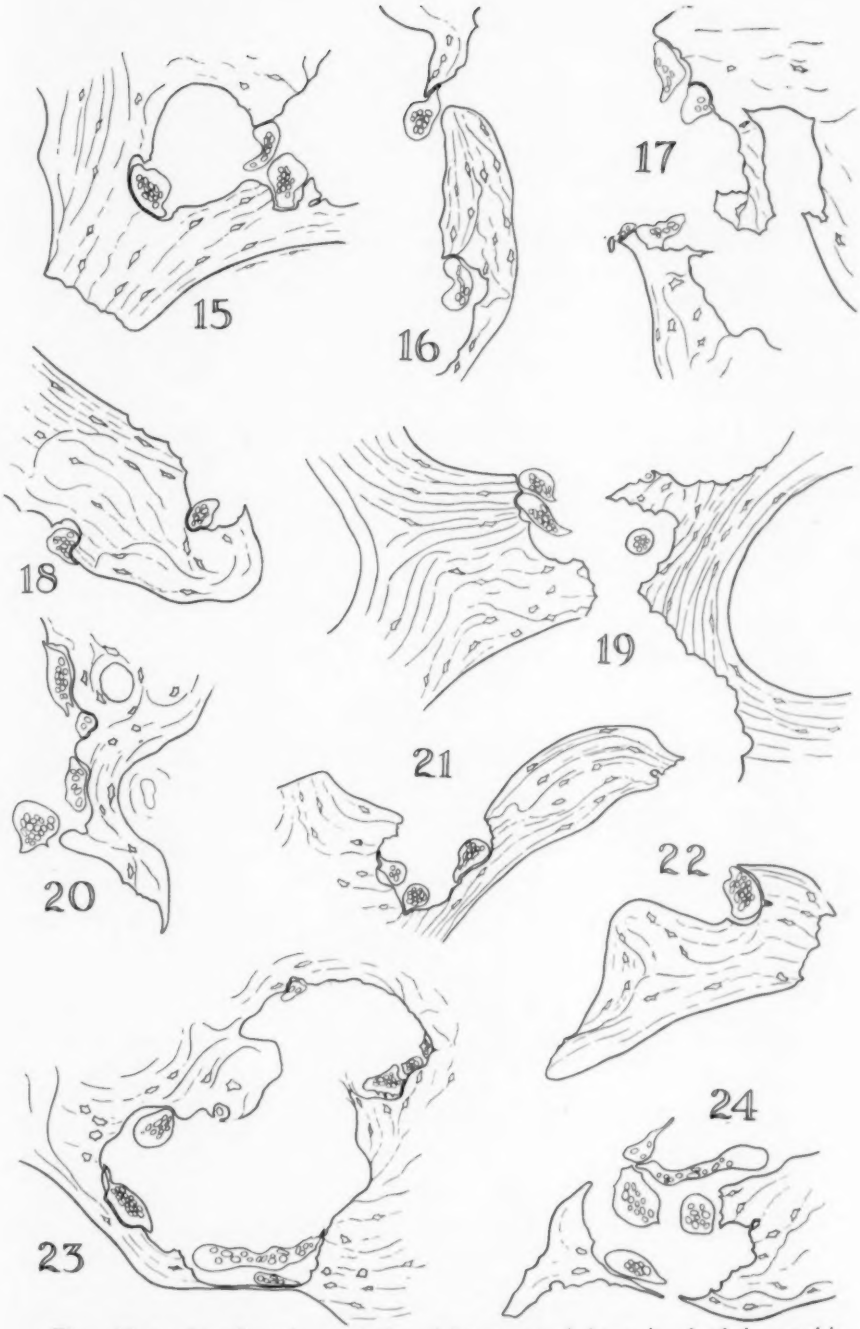


Figs. 5 to 14.—Drawings with the Edinger apparatus of areas selected from sections of the right temporal bone involved in osteitis deformans showing various forms of sculpturing and the relation of osteoclasts to the eroded surfaces. The magnification is 115 diameters.

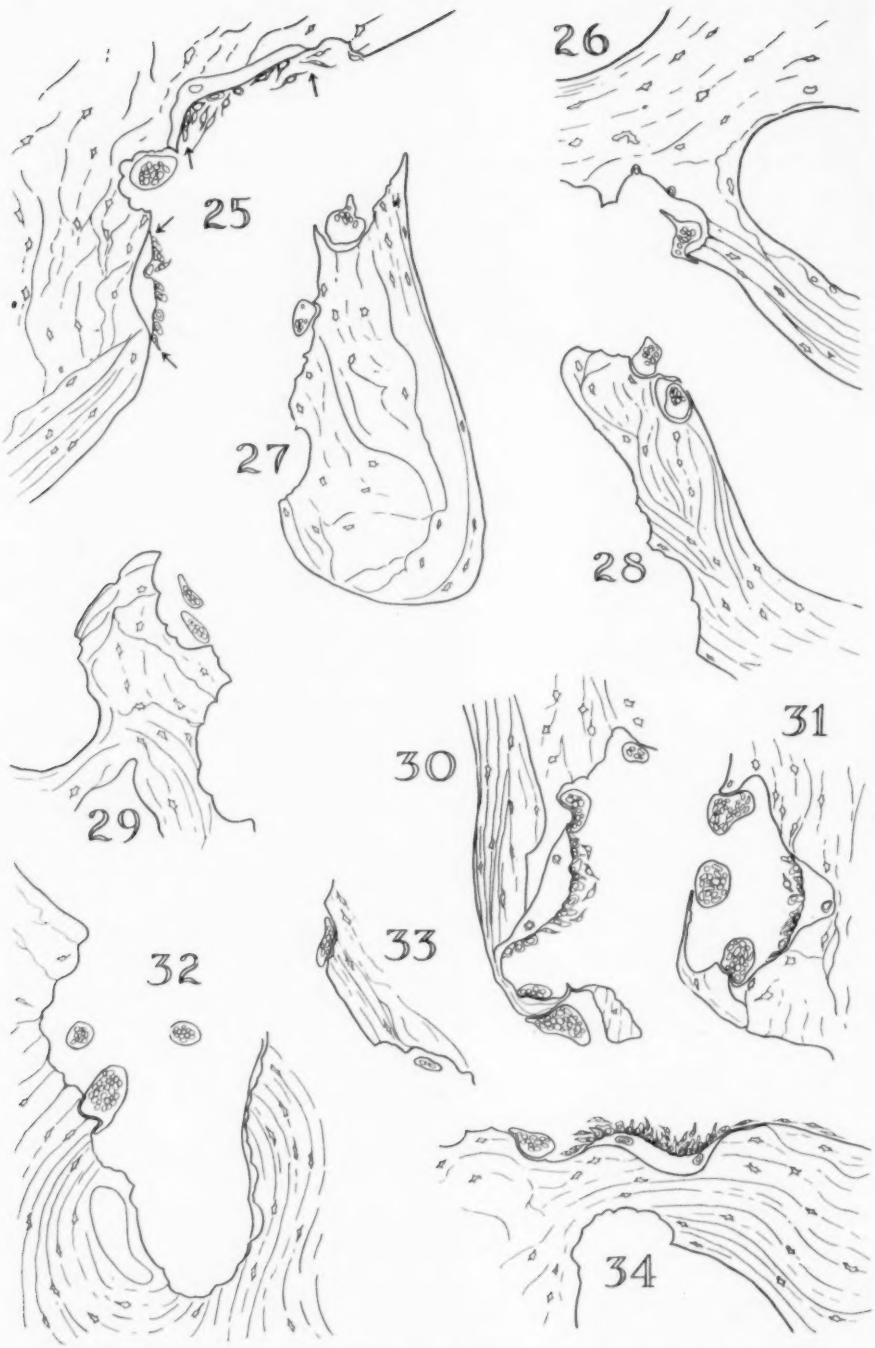
example, spear-shaped (fig. 7), falciform (fig. 8), pedunculate (fig. 10) or crescentic (fig. 9).

In some instances erosion occurs principally from within the haversian canal, ultimately laying it open (figs. 13 and 23); in many others the advance is from the exterior, so that the surrounding lamellae are gradually destroyed to expose the inner channel (figs. 12, 19, 26 and 32). Many stages in the process are to be found in each section in the series, from those of initial invasion (figs. 18 and 33) to those in which sculpturing has left only pointed projections (fig. 17), appendages connected by thin necks to the larger masses (figs. 9 and 30) or merely discontinuous pieces (fig. 24).

The absence of osteoclasts in normal bone has been to us a commonplace observation; in numerous series of sections of temporal bone we have noted this condition invariably, in those of fetuses at term, infants, children and adults to 70 years of age. Osteoclasts are, however, the chief agencies of resorption in our specimens of osteitic bone; they are present everywhere in the affected portions of the bone but are superabundant within the area of most active change in the right temporal bone (fig. 42). Except in these limited areas there is a remarkably uniform process throughout the portions of both bones showing the pathologic process. Although many of the giant cells lie free in the marrow, in by far the greater number of instances they are situated in close proximity to the bone, lodged within Howship's lacunae (figs. 5, 6, 15, 20, 23 and 28) or draped over the narrow tips of spicules (figs. 9, 12 and 17). They are numerous, as many as 14 appearing in a single low power field, in one section thirty being noted along one elongate spicule; the largest of these contain (in the thickness of one section) thirty or more nuclei. In the two areas of greatest destructive activity the cells are frequently arranged in lines (figs. 13, 23 and 40), often in a continuous series along the margin of an excavation. There are innumerable instances of close accommodation of the outline of the osteoclast to that of the small lacuna in which it rests (figs. 9, 13, 15, 17, 28 and 32), the conformity being so close at times that the cell follows even the slightest irregularities in the subjacent bone (fig. 39) by interdigitating pseudopodial projections (fig. 40); the close interrelationship of the cell and the pit indicates a local action of the osteoclast. This relationship makes clear the significance of the lesser pits of the eroded areas: They are the sites of activity of the small osteoclasts or of the larger ones, the narrowed extremities of which are in contact with bone (fig. 15, right bone, and 19, left bone). The same cell in an altered position or larger ones at work later may extend the hollows so that several small pits coalesce to produce a larger one (figs. 8, 14 and 25). Here and there old bone cells are seen, released



Figs. 15 to 24.—Drawings of the right temporal bone involved in osteitis deformans showing areas of eroded bone. The magnification is 115 diameters.



Figs. 25 to 34.—Drawings of the left temporal bone involved in osteitis deformans showing areas of eroded bone (with osteoclasts) and closely adjacent areas of newly formed bone (with osteoblasts). The limits of the two areas of newly formed bone are marked by arrows in figure 25; between them is an excavation occupied by an osteoclast. The magnification is 115 diameters.

from their lacunae by the removal of the investing lamellae (figs. 39 and 40).

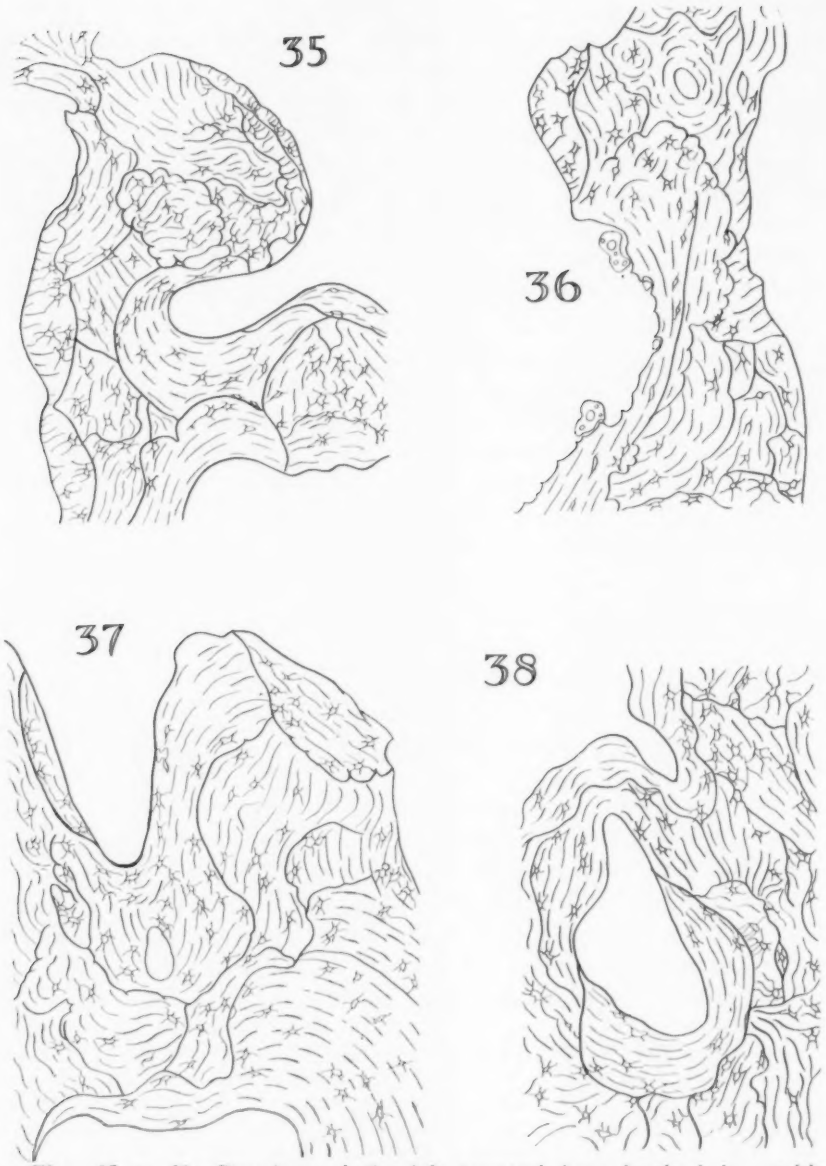
The osteoclasts assume a variety of forms, even within the confines of a single field (fig. 40); they are generally rounded or elongate, but often pseudopodia project from either the sides or the extremities. On the side of the osteoclast next the bone the boundary of the cell appears indefinite under lower power magnification and is seen to be fibrillated under higher magnification. The protoplasm just within the fringed border is definitely granular, as described by Dawson and Struthers,[4] and stains brightly with eosin; it is therefore markedly different from the opposite border, farthest removed from bone. The zone between the osteoblast and the bone is clear.

In our specimens all prominent degenerative changes can be ascribed to resorption by osteoclasts; there is no evidence of solution of cement substance through the resorbing power of perforating blood vessels, and only in the corelike areas of greatest activity is there any evidence of halisteretic atrophy; there (in sections stained according to Van Gieson's method) long fibrils occur, being apparently the only remaining connections between once continuous pieces of bone.

In the portions of the pathologic area where destruction of the matrix is most evident the new formation of bone is carried on most rapidly. This appositional growth occurs through the agency of the osteoblasts (figs. 30, 31 and 34).[10]

In these situations, where osteoblasts are actively depositing a matrix on the surface of previously eroded bone, a definite lamellar arrangement is not yet evident, the matrix still appearing to be homogeneous and usually containing a single stratum of bone cells; it is in all respects like embryonic bone, with osteoblasts alining themselves along the free surface of the forming matrix and gradually being covered in. The osteoblasts produce the matrix without relation to the previously existing deposits, so that the long axes of the old and those of the new lamellae rarely correspond; that is, the new bone is built on the persistent spicules of the old, with no correspondence save by chance in the patterns of

10. Leriche and Policard (The Normal and Pathological Physiology of Bone, St. Louis, C. V. Mosby Company, 1928) expressed the opinion, in opposition to the classic theory of Heinrich Müller, that "there is no coincidence between osteogenesis and the osteoblasts." In our study of rapidly changing bone, however, the areas of new formation have most closely associated with them osteoblasts in large numbers, arranged in a characteristic manner. Our opinions are in agreement with those of Key (cited by Leriche and Policard, pp. 42 and 43, footnotes), that a preosseous substance is being laid down smoothly beneath the epithelial layer of osteoblasts, and we consider that the production of this substance is, through some cellular mechanism, dependent on the presence of the osteoblasts, just as the eroded indentations are, owing to the activity of the osteoclasts, a causal relation not questioned by Leriche and Policard (p. 72).



Figs. 35 to 38.—Drawings of the left temporal bone involved in osteitis deformans showing areas of reconstruction. The superimposition of new bone on older excavations produces the characteristic mosaic structure. The heavier are the cement lines, the lighter are haversian lines. The magnification is 115 diameters.

lamination (figs. 35 to 38). In this manner the groundwork is laid for the intricate maze of separate lamellar patterns which characterizes bone involved in Paget's disease. These patterns are characterized too by the absence of haversian systems.

In the older portions of the reconstructed bone the semilunar outlines of the earlier lacunae are still in evidence, though they have since been filled with a matrix which is deep enough to be disposed in recognizable layers; once formed, the lacunae may be transitory, since osteoclasts often are seen at work in areas of bone unquestionably of recent origin (fig. 36). At many points there occur graphic records of the whole series of changes: Within an old area of destruction there is a lesser one of regeneration (fig. 25), and at the center of the latter there is in turn another area of concurrent erosion, the picture representing successive waves of osteolysis and lamellation. The resulting lamellar pattern little resembles that of the original unaltered tissue; it has been transformed, as pointed out by various investigators, into one in which stratification is no longer smooth and orderly but fragmented into a pattern of small juxtaposed pieces, graphically described as resembling a mosaic. The adjacent elements are marked off from each other by cement lines (Jaffe) which stain more prominently than the lamellar lines and are, we note in our series, the site of frequent minute fractures produced by pressure sustained in the sectioning. That they form lines of easy cleavage indicates incomplete cementing of the old and the new lamellae.

In the temporal bone of the left side, in which the process was less active, there are occasional very small areas of fibrosis, which suggest an aging granulation tissue or a callus formation; they are associated with localized patches of osteoclasis. In this bone the reparative predominate over the destructive processes, osteoclasts being much less numerous than in the bone of the right side. Small areas of recent formation are correspondingly more numerous, there being from three to eight evident in each section; commonly they are elongate and shallow, with the lamellae usually passing at right angles to those of the old bone. The osteoclasts in this temporal bone are few; although seen in every section, they are separated by wider distance than those noted in the sections of the bone of the right side and never are in clumps or lots. In this bone, too, are areas of erosion which have not yet become areas of subsequent regeneration; they seem entirely untouched by the mechanism of repair, with opened haversian canals and thinned spicules occurring where osteoblasts are wanting, as if situated in an abandoned territory. In general, destruction has not been as complete as in the bone of the right side, since at least a few spicules of bone project from the intact cochlear shell into the very center of the pathologic process, unaffected by the surrounding changes. The

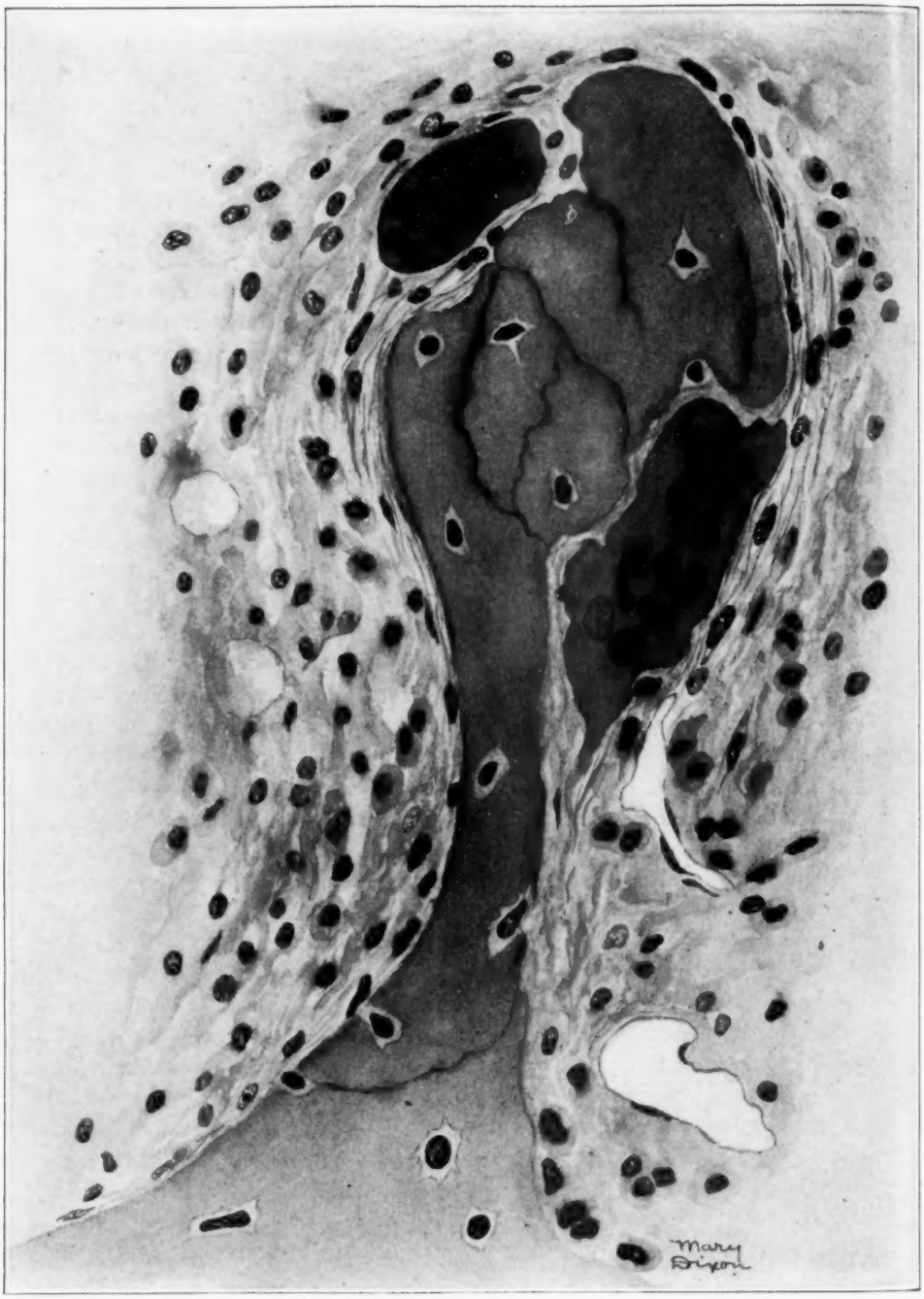


Fig. 39.—This drawing shows an enlarged haversian space in the temporal bone of the right side. The excavations along the margin of the space are occupied by osteoclast giant cells. The magnification is 520 diameters.

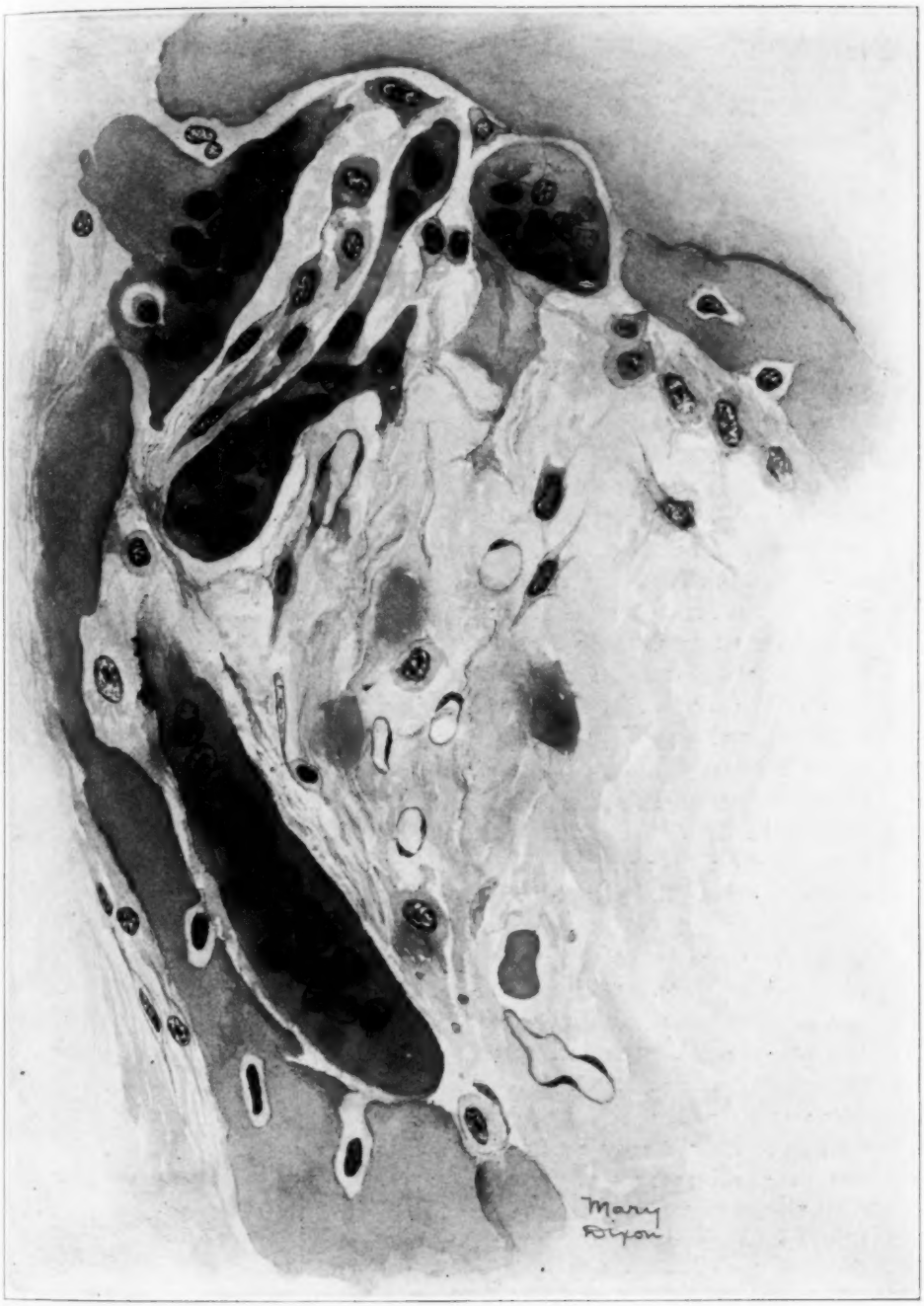


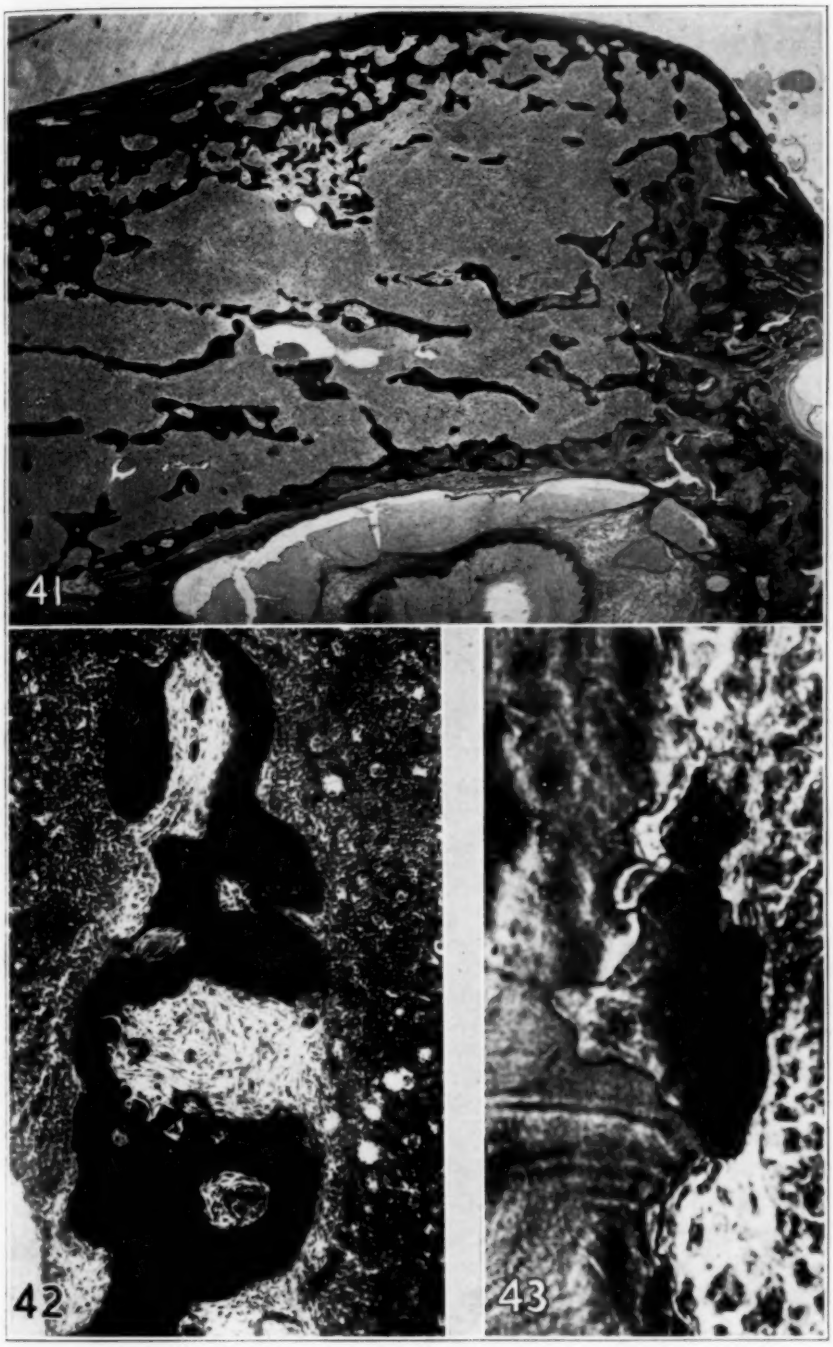
Fig. 40.—This drawing (made from a section of the same series as those in the preceding figures) shows a persisting spicule of bone, with lines of the interrupted haversian lamellae and osteoclasts within marginal indentations. The magnification is 520 diameters.

extent to which the osseous labyrinthine capsule is affected in such areas of dystrophy in cases of Recklinghausen's and Paget's disease has been fully investigated and discussed by Nager (1933), who stated that in Recklinghausen's disease the lesion begins in the capsule of the periosteal labyrinth, where it may be associated with otosclerosis; in osteitis deformans, however, the capsule of the labyrinth shows reconstruction of all its layers of an extent and intensity observed in no other disease of bone (Nager). Complete capsular layers are almost wholly decomposed and rebuilt, so that in the progressive stages only entirely detached fragments of endochondral capsule immediately about the cochlea remain.

In our sections it appears that one portion of the entire bone does possess more than the usual power of resistance to the destructive agencies. We refer to the immediate area of the cochlea. The picture in our preparations suggests that this circumstance is linked causally with the special character of the osseous tissue in that territory, since even when the osteitis has spread beyond cancellous marrow to include the posterior wall of the internal acoustic meatus and the lateral wall of the carotid canal (so that the cochlea is surrounded on three sides by a pathologic process) there still occurs no involvement of the bone which immediately houses the cochlea. The formation of the intrachondrial bone (islands of cartilage or interglobular spaces) was carefully described by Bast [11] (1930). In the fetus and in the infant, as is well known, intrachondrial bone forms a striking feature of the periotic capsule, where it is confined to the bone immediately surrounding the membranous labyrinth, and as a shell separated from the general bone of the capsule by a cleft filled with marrow; although its ultimate distribution is broader, it does not extend into the diploic bone. We have frequently observed that in the general process by which fetal and infantile bones grow and undergo alteration in shape the intrachondrial tissue proves unusually resistant; where marrow tissue is encroaching on bone the islands of modified cartilage are left jutting into the cavities as finger-like processes or bridges, appearing histologically as almost amorphous remnants; likewise, in specimens from older persons (70 years of age), although the diploic bone is rarefied, the compact cochlear mass remains unaffected.

In the membranous labyrinth no changes occurred that could be regarded as the effects of the osteitis; in a limited area of the cochlea the tectorial membrane and the vestibular membrane (Reissneri) were adherent, a condition probably not due to the current disease. The sections show that the acoustic nerve (in the depths of the internal acoustic meatus), the trigeminal ganglion and the neighboring cranial

11. Bast, T. H.: Ossification of the Otic Capsule in Human Fetuses, Contrib. Embryol. (no. 121) **21**:53, 1930.



Figs. 41 to 43.—Sections of the same series as those in figures 5 to 24, showing: in figure 41, a portion of the bone anterior to the cochlea, near that shown in figure 4, showing spongiose tissue (magnification × 8); in figure 42, an area of marked destruction by osteoclasts, rebuilding by osteoblasts and characteristic young fibrous tissue (magnification × 85), and in figure 43, an osteoclast and the eroded recess, to the outline of which its margin is closely accommodated (magnification × 460).

dura mater all contain deeply staining roundish bodies of hyaline appearance; they are dural endotheliomas, known to occur commonly in the nerves of older persons. The bodies are numerous, as many as 15 appearing in a low power field. They are lodged in the small blood vessels of the endoneurial connective tissue and appear in all sections which include the nerves. Various manifestations of the hyalinization are observable, the earliest of which is seemingly the formation of a whorl by the fibroblasts, with resultant thickening of the wall and narrowing of the lumen; this stage is followed by complete obliteration of the cavity and hyalinization of the concentrically arranged layers of the whorl, either circularly or in the form of irregular masses, some of which are elongate. They, like the alterations in the labyrinthine structures, seem to have no necessary association with the osseous changes.

COMMENT

Our observations on the histologic features in a case of Paget's disease are in essential accord with those of other investigators, so far as they could be manifest in the rather specialized tissue of the petrous portion of the temporal bone. We found extensive resorption by osteoclasts and marked formation of new osseous tissue by osteoblasts, the lamellated additions being made on the definitely outlined and deeply sculptured surfaces of the original trabeculae; in small areas at least there was a transformation of marrow into young connective tissue. In our specimens, however, we found no evidence of metaplasia, i. e., the direct transformation of fibrous into osteoid tissue.

Osteolysis affects all the diploic bone which lies medial to the cochlea; it is carried out by resorption through the direct action of osteoclasts, which are numerous and lie chiefly within recesses along the trabeculae; typically, the surface of the cell next the bone is closely accommodated to even minute irregularities, is granular and is fibrillated, as illustrated by Dawson and Struthers (their fig. V, 1), a specialization that points again to the activity of osteoclasts not only in dissolving but in removing the matrix of the old bone. All stages of destruction are present; some haversian canals are but slightly enlarged from within, and others are so completely destroyed that the lamellar plan is scarcely traceable; a few trabeculae are little altered, but others persist as mere fragments. The marrow, generally hematopoietic, is, wherever osteoclasts are arranged in active clusters, changed to a network of young connective tissue cells among which capillaries are abundant.

In the preceding observations we have described the striking mosaic constitution of the diseased bone, a feature of the histopathologic picture of Paget's disease justly emphasized in recent accounts by several investigators. Schmorl [1] pointed out that although mosaics occur rarely in

osteitis fibrosa (Recklinghausen's disease), osteoplastic carcinosis and even syphilitic periostitis, it is only in osteitis deformans that mosaics are so abundant and so sharply outlined as readily to catch the eye; in the other diseases named they appear in isolation, and to establish their presence requires a search. The matter of degree of difference did not, however, seem as important to Nager and Meyer, who linked closely the various manifestations of osteodystrophia, regarding even otosclerosis as a specialized form which owes its distinctive character to the "almost marrowless compactness" and "partly embryonic structure" of the temporal bone.

In emphasizing the extent to which bone in Paget's disease is reconstructed Nager also pointed to the mosaic pattern as characteristic of the secondary tissue. Jaffe (1933), in an excellent account of the microscopic anatomy of this disease, emphasized this architectural result of the "complicated cycle of bone resorption and apposition" to which the new as well as the old bone is subjected, "each new encroachment on the bone that is being resorbed leaving a resorption line, part or all of which remains as a cement line when the new bone is deposited"; these lines "with the intervening fragments of bone create the mosaic architecture."

The abundance of the cement lines and the clarity with which they may be seen are amply demonstrated in our figures; they persist in the regions of currently resting bone, their crenated form still being evident even where covered in by an increment of younger matrix.

It may be pointed out in conclusion that the progress and the result of Paget's disease are essentially the same in the diploic portion of the petrous temporal bone as in any long bone or in the skull generally. However, the exceedingly compact cochlear part would seem to present some definite resistance to the progress of the destructive forces; we suggest that the presence of intrachondrial bone, found elsewhere to be a very stable tissue, accounts in part at least for its immobility. Observations now in progress on specimens of bone involved by other diseases must be extended to determine if this opinion is warranted.

NOTE.—Since the article was written, we have examined sections made in two additional cases of Paget's disease in more advanced stages and noted: 1. The marrow in the petrous tip was almost entirely replaced by vascular connective tissue, with a sprinkling of fatty cells, the bone showing the characteristic mosaic structure. 2. The periotic capsule was invaded in many areas but with less destruction than at the petrous tip. 3. The bone in the area between the cochlea and the stapes was almost entirely replaced by mosaic bone and vascular connective tissue; in one case vascular fibrous tissue predominated.

A detailed account will be published later.

INTRA-UTERINE AND NEONATAL OTITIS

A STUDY OF SEVEN CASES INCLUDING A CASE OF OTITIC MENINGITIS

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NEW YORK

The solid constituents of amniotic fluid and the associated cellular exudate so frequently found post mortem in the middle ear of the new-born infant have been regarded as evidence of a condition distinct from otitis media of infancy.[1] Opinions as to their nature and significance have been diverse. Zaufal[2] thought them a product of spontaneous degeneration of the embryonal mucosa; Aschoff,[1b] a foreign body reaction, and Hartmann,[3] a factor predisposing to secondary infection. Ascending infection of the amniotic fluid in cases of premature rupture of the fetal membranes has long been demonstrated,[4] and the association of premature rupture of the membranes with intra-uterine aspiration pneumonia has been shown.[5] Infection of the middle ear through the same course of events has been suggested as a possibility,[6] but illustrative cases are not found in the literature. A consideration of this factor forms a part of the following report of cases, which have been selected to illustrate certain types of exudative otitic reactions in the mature fetus and in the mature new-born infant.

Aided by grants from the Research Committee of the American Otological Society.

Read (by invitation) at a meeting of the New York Academy of Medicine, Section of Otolaryngology, May 15, 1935.

From the Department of Otolaryngology, New York Postgraduate Medical School and Hospital, Service of Dr. Marvin F. Jones, Dr. Duncan Macpherson, Director.

1. (*a*) Baréty, A., and Renaut, J.: Anatomie pathologique de l'otite interne des nouveau-nés, Arch. de physiol. norm. et path. **2**:374, 1869. (*b*) Aschoff, L.: Die Otitis media neonatorum, Ztschr. f. Ohrenh. **31**:295 (Oct.) 1897.

2. Zaufal, E.: Sectionen des Gehörorganes von Neugeborenen und Säuglingen, Oesterr. Jahrb. f. Pädiat. **1**:118, 1870.

3. Hartmann, A.: Die Mittelohrentzündung der Säuglinge, Deutsche med. Wchnschr. **20**:544 (June 28) 1894.

4. Hellendall, H.: Bakteriologische Beiträge zur puerperalen Wundinfektion, Beitr. z. Geburtsh. u. Gynäk. **10**:320, 1906.

5. (*a*) Browne, F. J.: Pneumonia Neonatorum, Brit. M. J. **1**:469 (March 25) 1922; Neo-Natal Death, ibid. **2**:590 (Sept. 30) 1922. (*b*) Johnson, W. C., and Meyer, J. R.: A Study of Pneumonia in the Stillborn and Newborn, Am. J. Obst. & Gynec. **9**:151 (Feb.) 1925.

6. Gomperz, B.: Pathologie und Therapie der Mittelohrentzündungen im Säuglingsalter, Vienna, Josef Šafář, 1906.

Of the solid constituents of amniotic fluid (cornified epithelial cells, vernix caseosa and lanugo) the most easily demonstrated in embedded and sectioned material are the cornified cells. The presence of cornified cells in the middle ear after the fifth month of fetal life was demonstrated by Wendt [7] in 1873. In the ear, as in the lungs,[8] greater numbers of cornified cells are found when intra-uterine asphyxia has resulted in intra-uterine aspiration.

MATERIAL AND METHODS

The cases were observed in the New York Lying-In Hospital in the years from 1930 to 1932. The autopsies were performed by me. By permission of the senior surgeons, Dr. Asa B. Davis and Dr. James A. Harrar, the otologic material was placed at the disposal of the consultant otologist, Dr. Marvin F. Jones, under whose auspices this study has been made. Since August 1932 this work has been continued in the department of otolaryngology of the New York Post-Graduate Medical School and Hospital. Observations were assembled on 60 mature newborn infants and nonmacerated fetuses on which autopsy was performed before any marked degree of postmortem degeneration had occurred, and from this group the cases reported here have been selected. The Wassermann reactions of the mothers were negative, and none of the infants showed evidence of syphilis on postmortem examination.

Pending autopsy the bodies were placed in a large mortuary refrigerator at a temperature of from 3 to 5 C. The petrous portion of the temporal bones was fixed in a solution of formaldehyde after removal, and serial sections from 16 to 24 millimicrons in thickness were cut after being embedded in pyroxylin (celloidin). Tracer sets, consisting of every tenth section, were stained with hematoxylin and eosin, and the intermediate sections were stored for further study. MacCallum's modification of Goodpasture's method was used for staining bacteria in the tissue.

REPORT OF CASES

CASE 1.—The patient was a full term stillborn infant whose intrapartum death was caused by a true knot in a short umbilical cord. The membranes were ruptured for fifteen minutes before delivery, which was spontaneous. Autopsy forty-four hours post mortem revealed aspiration of amniotic fluid into the lungs. The tympanum (fig. 1 *A* and *B*) showed numerous groups of cornified epithelial cells, which when viewed on edge formed dark, narrow, waved lines. There was a mild foreign body reaction, with endothelial leukocytes and multinucleated foreign body

7. Wendt, H.: Ueber das Verhalten der Paukenhöhle beim Fötus und beim Neugeborenen, Arch. d. Heilk. **14**:97, 1873.

8. Farber, Sidney, and Sweet, L. K.: Amniotic Sac Contents in the Lungs of Infants, Am. J. Dis. Child. **42**:1372 (Dec.) 1931.

giant cells. In figure 1*D* is shown a cornified cell surrounded by a giant cell. The vascularity of the tympanic mucosa and membrane was normal for a stillborn fetus or new-born infant. Embryonal mucosa was present in the recessus epitympanicus. Stains for bacteria gave negative results. This exudate was evidence of a mild foreign body reaction.

CASE 2.—The infant was delivered by low two flap cesarean section after a trial labor in a woman with a flat pelvis; the membranes were ruptured nine hours before delivery. The fetal heart was last heard ninety minutes before operation. The mature infant was stillborn, and autopsy, performed four hours post mortem,

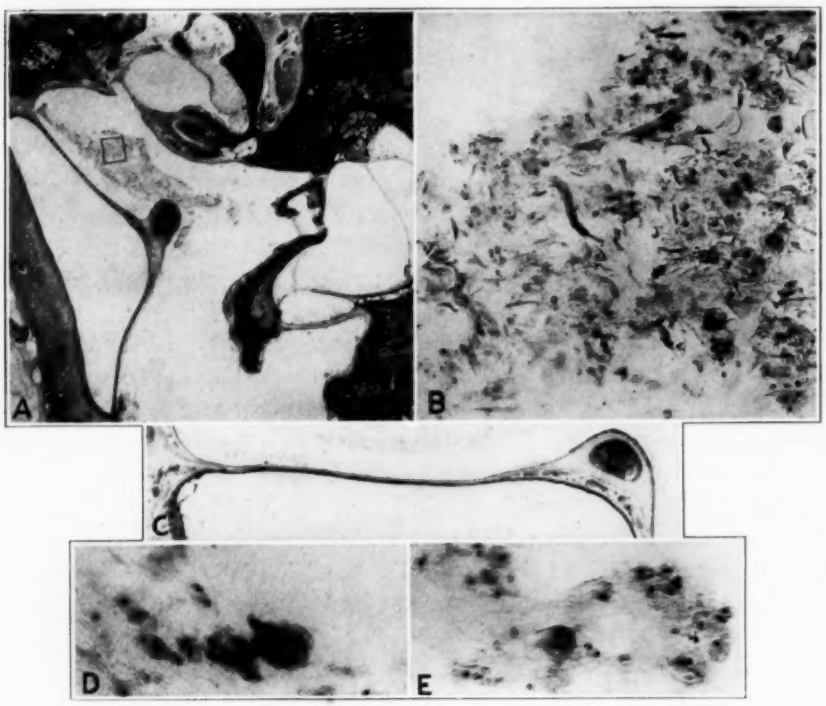

Fig. 1 (case 1).—*A* is a vertical section showing a thin cellular exudate in the cavum tympani. Remnants of embryonal mucosa are present in the recessus epitympanicus; × 6. *B* shows the area marked off in *A* at a magnification of 100 diameters. Cornified cells, viewed on edge, are seen as dark, narrow, waved lines. A number of large round cells and giant cells are present. In *C* the tympanic membrane is seen to be normal for a new-born infant; × 13. *D* and *E* are higher magnifications of the large phagocytic cells with a cornified cell (*D*) surrounded by a giant cell; × 215.

indicated asphyxial death. Sections of the ear (fig. 2) showed, in addition to the cornified cells, a large amount of polymorphonuclear exudate in the middle ear. The tympanic mucosa and membrane were normal, and bacterial stains failed to demonstrate organisms. I therefore considered this exudate evidence of a marked degree of foreign body reaction.

CASE 3.—A full term Negro infant was delivered spontaneously after a total labor of fifty hours of a woman in her first pregnancy. The membranes were ruptured at the beginning of the second stage of labor, six hours before delivery. The infant lived eight hours. Autopsy twelve hours post mortem revealed excessive molding of the cranial vault and marked vascular congestion. There was pulmonary consolidation with bronchial distribution (fig. 3*C*), with a few polymorphonuclear cells, a large amount of vernix caseosa and a few cornified cells. In the middle ear (fig. 3*A* and *B*) were seen serous exudate and cornified cells amid masses of polymorphonuclear cells. The vascular injection of the tympanic

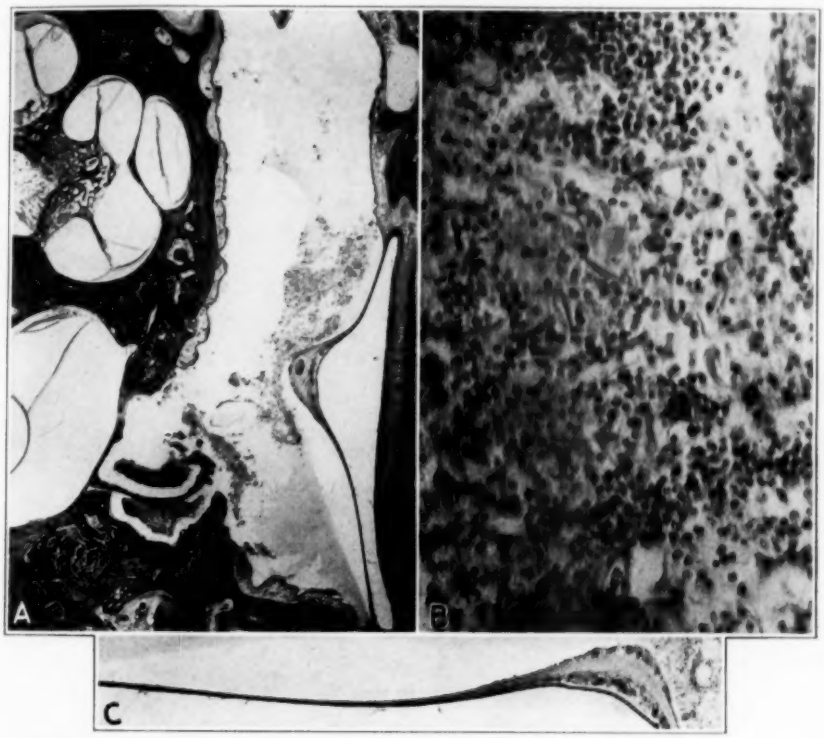

Fig. 2 (case 2).—*A* is a horizontal section showing serous exudate and a thin cellular exudate near the tympanic membrane. A thicker mass of cellular exudate is present about the stapes. The mucosa, of the embryonal type, is not infiltrated; × 6. *B* shows the area marked off in *A* at a magnification of 215 diameters. The cornified cells are swollen, and numerous polymorphonuclear cells are present. *C* shows a section of the normal drum; × 13.

mucosa was part of the generalized congestion. The tympanic membrane was normal. Gram's stain (fig. 3*D*) disclosed groups of intracellular and extracellular gram-positive cocci, and I therefore considered the exudate to be the result of an inflammatory process. Incidentally, in figure 3*A* the first turn of the cochlea shows profuse hemorrhage in the ductus cochleae which, had the infant lived, undoubtedly would have resulted in loss of hearing of high tones. Hemorrhage was noted also in the perilymphatic space of the utricle.

CASE 4.—A full term white infant died at the age of 2 days of traumatic cerebral injuries following difficult extraction in a breech presentation. The membranes had been ruptured for twenty-one hours. Autopsy was performed sixteen hours post mortem; there was no gross evidence of pneumonia. The cavum tympani (fig. 4 *A* and *B*) contained a few cornified cells and a thick polymorphonuclear exudate surrounding a central area of hemorrhage. The tympanic membrane (fig. 4 *D*) was normal, and the congestion of the epitympanic vessels was possibly within normal limits. Gram's stain (fig. 4 *C*) disclosed numerous gram-positive lancet-shaped diplococci in pairs and chains. The dark spots in areas

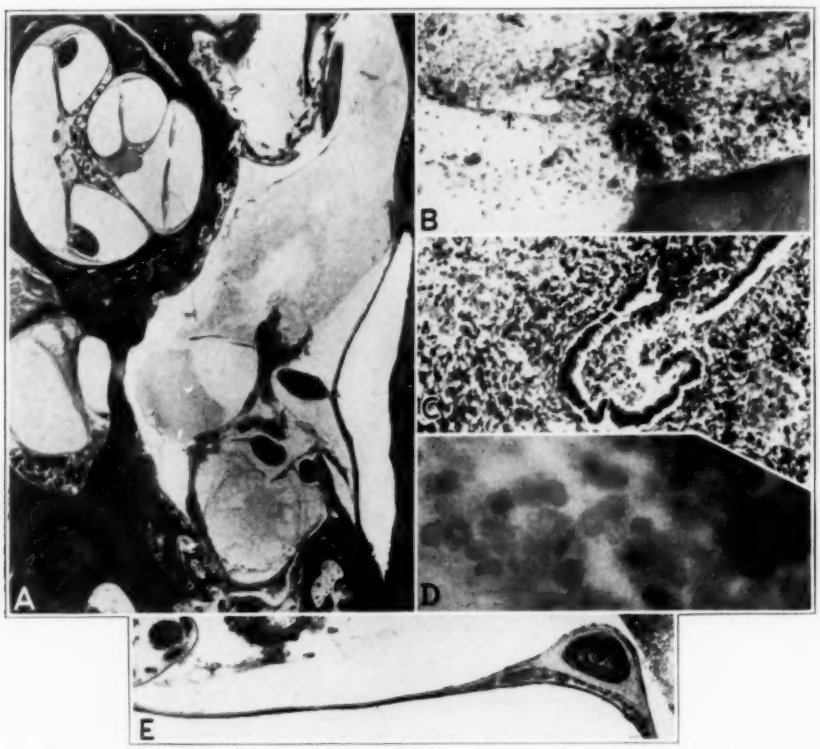

Fig. 3 (case 3).—*A* is a horizontal section showing serous exudate throughout the cavum tympani and masses of cellular exudate about the ossicles and the posterior wall of the cavity. Vascular congestion is marked. Profuse hemorrhage is seen in the first turn of the ductus cochleae, and hemorrhages are present also in the perilymphatic space of the utricle; × 6. *B* shows a higher magnification of the antrum, with the arrows indicating the epithelium against which are pressed many cornified cells; × 100. *C* shows lung tissue, with polymorphonuclear cells, large amounts of vernix caseosa and a few cornified cells; × 100. *D* shows intracellular and extracellular gram-positive cocci in the tympanic exudate; × 550. *E* shows the normal structure of the drum; × 13.

y and *z* of fig. 4 *A* were masses of bacteria amid liquefied pus. This case was one of acute purulent otitis media without associated pneumonia following premature rupture of the fetal membranes.

CASE 5.—A full term white infant was delivered by extraction in breech presentation, the membranes having been ruptured for twenty-four hours. The infant died at the age of 2 days. Autopsy fifty-three hours post mortem revealed bilateral pneumonia with bronchial distribution and many cornified cells in the lungs. The tympanum and antrum (fig. 5 *A*, *B* and *C*) showed many cornified cells and much pus, and the vessels of the tympanic mucosa and membrane were injected. Gram-positive bacteria were stained in the exudate (fig. 5 *E*). This case was one of acute purulent otitis media and antritis with associated aspiration pneumonia following premature rupture of the fetal membranes.

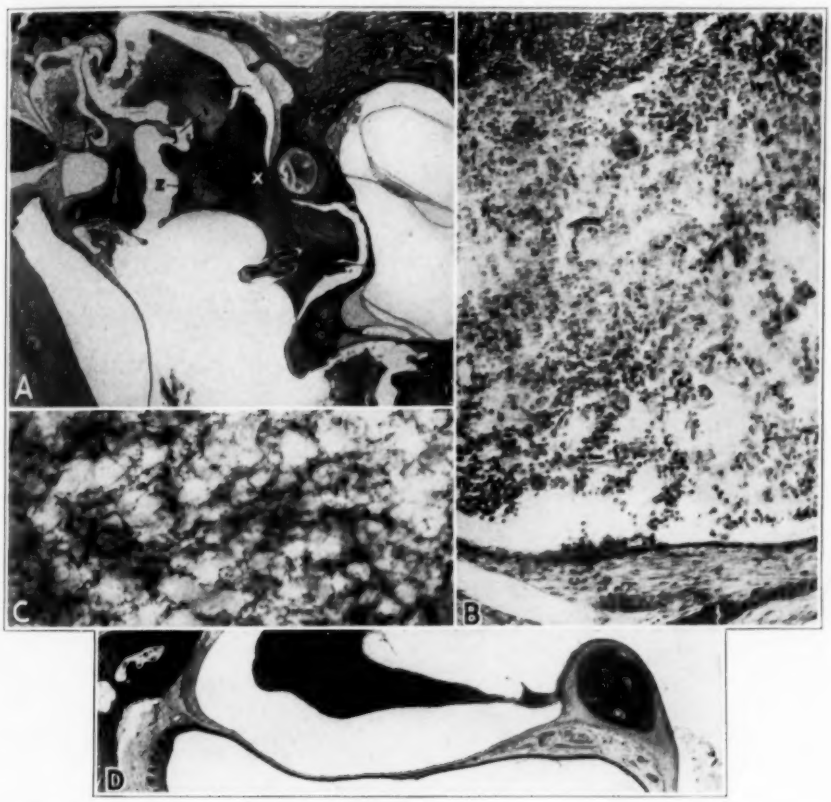

Fig. 4 (case 4).—*A* is a vertical section. The thick exudate in the recessus epitympanicus and along the medial wall of the cavum tympani consists of pus surrounding an area of hemorrhage (*x*) opposite the aqueductus Fallopii. The dark spots in areas *y* and *z* are masses of bacteria. The mucosa shows little, if any, reaction to the inflammation; × 6. *B* shows the area marked off in *A* at a magnification of 100 diameters. There are a number of cornified cells, large round cells and giant cells, with masses of polymorphonuclear cells in the upper portion. *C* shows the gram-positive bacteria indicated in *Az*; × 550. The drum (*D*) is possibly within normal limits; × 13.

CASE 6.—A mature white infant from the outdoor department was born spontaneously in vertex presentation, after an uncomplicated labor of six hours.

The membranes had been ruptured for forty minutes. The mother, a young primipara, was well before and after delivery. The infant was well until the fifth day, when it died after a short illness, with a terminal elevation of temperature to 102.8 F. Autopsy twelve hours post mortem revealed a mild stage of purulent leptomeningitis and small areas of pulmonary consolidation. The petrous portion of the temporal bones one the right side (fig. 6 *A* and *B*) showed a great amount of pus but no cornified cells in the tympanum, while the aditus and antrum were filled with pus. The tympanic mucosa and membrane

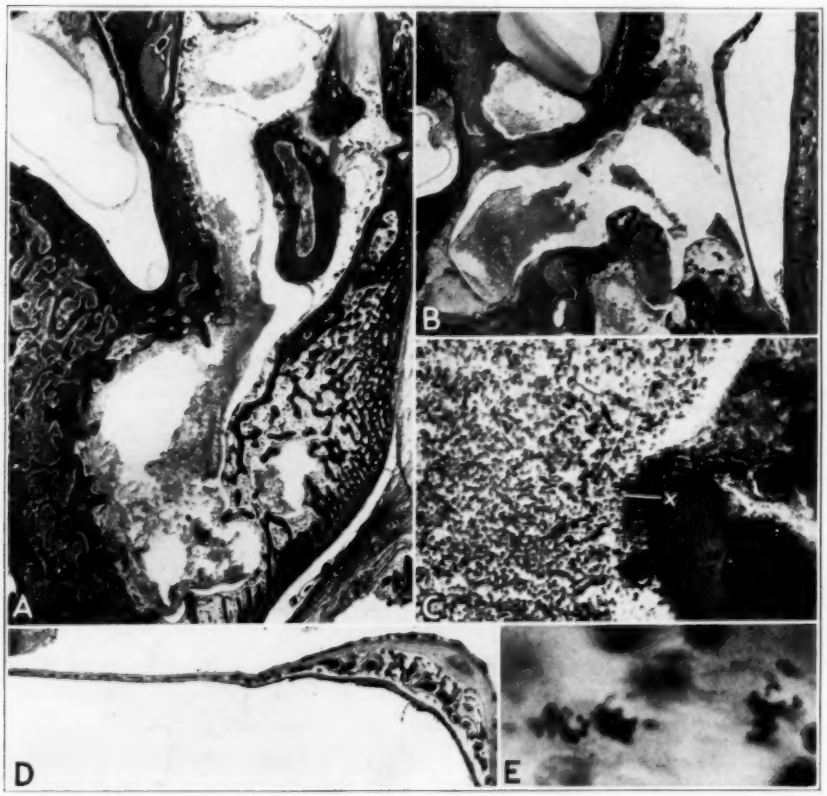

Fig. 5 (case 5).—*A* is a horizontal section of the recessus epitympanicus, aditus and antrum. Cellular exudate is abundant. Vascular congestion is more marked in the cavum tympani than in the antrum; × 6. *B* shows cellular exudate and vascular congestion at the level of the round window; × 6. *C* shows the area marked off in *A* at a magnification of 100 diameters. The mucosa is necrotic at the point *x*. Polymorphonuclear cells, large round cells and cornified cells are present in the exudate. *D* shows the drum, definitely injected; × 13. *E* shows gram-positive cocci in the exudate; × 1,000.

(fig. 6 *D*) were injected, and the mucosa of the antrum showed infiltration of polymorphonuclears and areas of necrosis. Gram's stain disclosed many gram-positive lancet-shaped diplococci in the exudate from the process on the right side (fig. 6 *C*). On the left side the tympanum and antrum (fig. 7 *A* and *B*)

were free from exudate. On the right side (fig. 8 *A*) the dura mater in the region of the saccus endolymphaticus was thickened and infiltrated by leukocytes and bacteria. A platelet thrombus was present in one of the veins (fig. 8 *C*). The saccus endolymphaticus (*x*) was distended. (In these preparations its walls were normally in apposition.) The cellular exudate in the pia-arachnoid of the pons (fig. 8 *B*) showed organisms of the same morphology and staining reaction as those in the middle ear and dura mater. Sections of the cochleae (fig. 9) showed early purulent labyrinthitis on both sides, with a radial distribution of the exudate from the modiolus. Leukocytes were present also in the cochlear aqueduct.

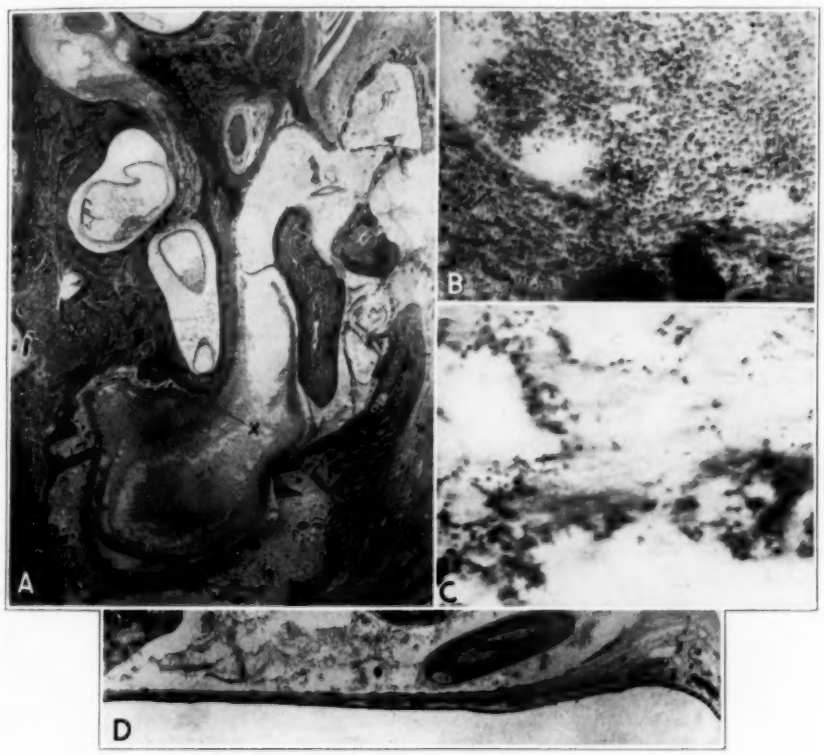

Fig. 6 (case 6).—*A* shows a horizontal section of the right recessus epitympanicus, aditus and antrum. The involvement resembled that in case 5 except that a larger quantity of pus was present in the antrum. The antral mucosa was involved and necrotic over the horizontal semicircular canal (*x*); × 6. *B* shows tympanic mucosa and exudate; × 100. *C* shows gram-positive lancet-shaped diplococci from the exudate of the middle ear; × 1,000. *D* shows the greatly injected drum; × 13.

On the right side (fig. 7 *C*) the pus in the middle ear lay in apposition to the oval window, but an inflammatory reaction was not present in the adjacent labyrinth. The exudate (*x*) internal to the secondary tympanic membrane (fig. 7 *D*) was, I believe, the result of an inflammatory reaction. However, the general distribution of the cellular exudate in the two cochleae indicated

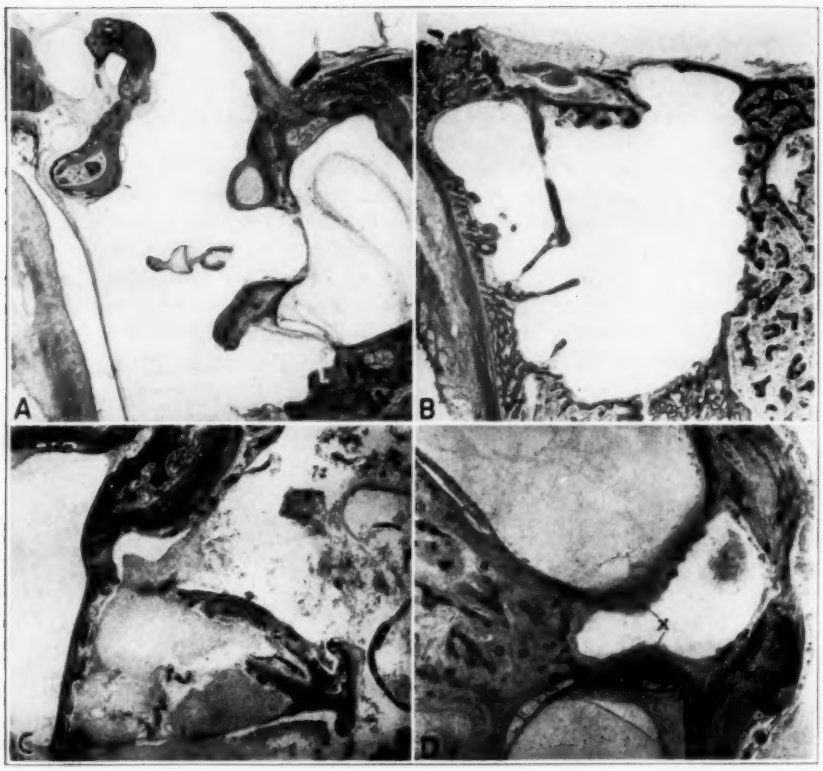

Fig. 7 (case 6).—*A* and *B* are vertical sections of the left ear showing normal structure of the cavum tympani and antrum; × 6. *C* and *D* are horizontal sections of the right ear, showing the cellular exudate in the cavum tympani adjacent to the round and oval window. *X* in *D* shows an inflammatory reaction internal to the secondary tympanic membrane; × 13.

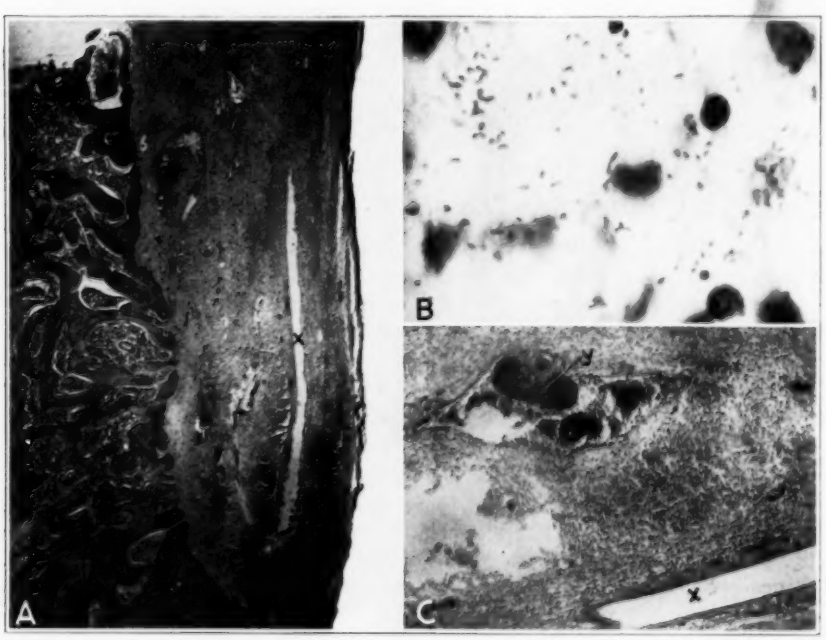

Fig. 8 (case 6).—*A* is a section of thickened dura mater in the region of the right saccus endolymphaticus (*x*); × 10. *B* shows gram-positive diplococci from the pia-arachnoid of the pons; × 1,000. *C* is a higher magnification of the region in *A*, showing the cellular exudate in the dura; *y* indicates a platelet thrombus in a large vein; *x*, the saccus; × 45.

infection of the labyrinth by way of the modiolus rather than through the secondary tympanic membrane. The infection did not appear to have traveled through the fissula ante fenestram. I considered this case one of primary unilateral purulent acute otitis media with secondary purulent meningitis and with early bilateral purulent labyrinthitis secondary to the meningitis. Evidence indicated that the infection reached the brain by venous channels from the mastoid antrum. It was not apparent that delivery bore a causal relationship to the infection.

CASE 7.—A mature white infant was delivered spontaneously after a labor of thirteen hours, the membranes having been ruptured for two hours. The infant

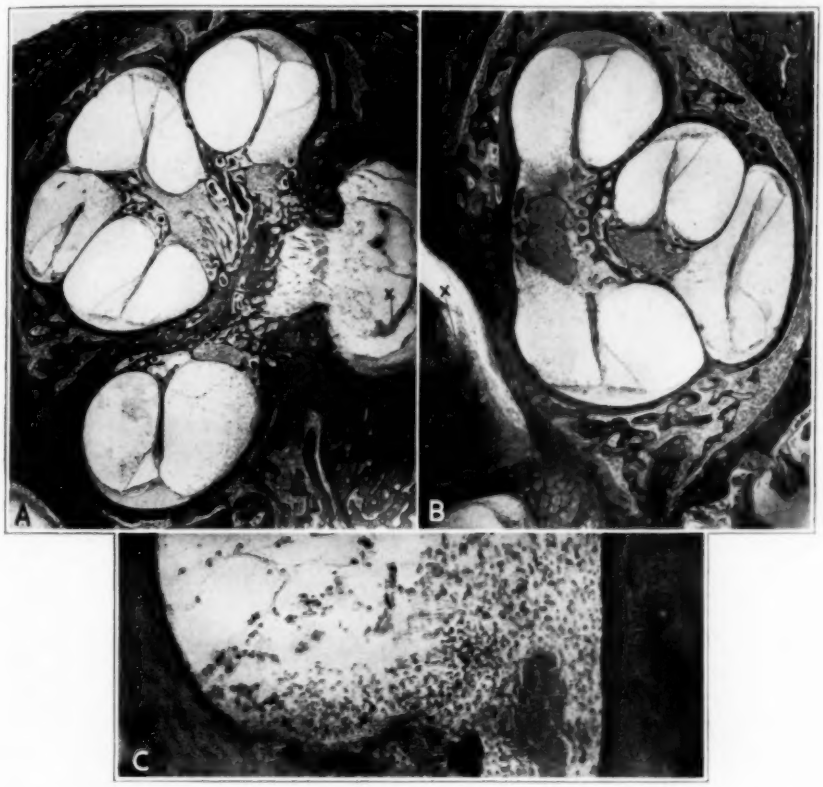

Fig. 9 (case 6).—*A* is a midmodiolar vertical section of the left cochlea and *B* a horizontal section of the right cochlea. Both show cellular labyrinthitis, with the exudate radiating from the modiolus; *x* marks the cellular exudate in the internal auditory meatus; *C* is a higher magnification of the scala tympani from an adjacent section on the left; × 100.

was normal until the ninth day, when mild nonspecific conjunctivitis developed. This cleared up by the seventeenth day, at which time erysipelas developed on the scrotum, and the temperature, hitherto normal, rose to 103.6 F. and remained elevated until death on the twenty-second day. At autopsy, performed seventeen hours post mortem, the erysipelas was seen to extend from the level of the umbilicus to the thighs. There was generalized pyemia, as evinced by pneumonia,

purulent pleurisy and peritonitis. The tympanum (fig. 10) showed an organizing exudate, with large numbers of long chain streptococci (fig. 10 *C*). Figure 10 *B* shows the exudate adjacent to the stapedial mucosa, with fibroblastic and capillary proliferation from the mucosa. The tympanic mucosa, however, showed injected vessels and foci of distinct perivascular infiltration by polymorphonuclears. The tympanic membrane was much injected. Cornified cells were not seen. This was a case of agonal infection of the middle ear as part of pyemia associated with the primary organizing otitis media.

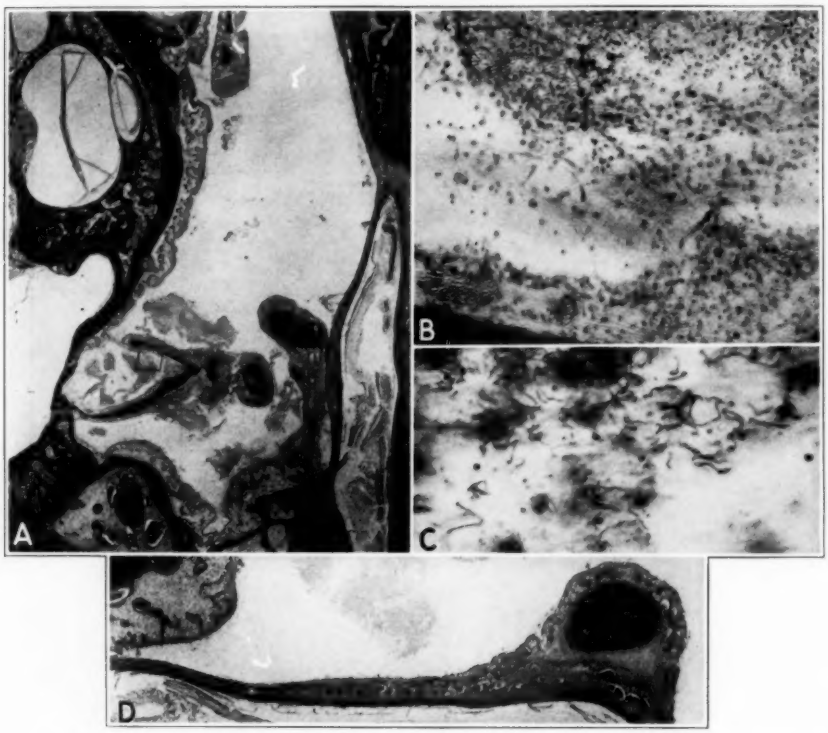

Fig. 10 (case 7).—*A* is horizontal section of the cavum tympani at the level of the oval window. The mucosa shows a degree of hyperplasia not seen in the previous sections. Masses of cellular exudate are seen about the stapes; × 6. *B* shows the area marked off in *A* at a magnification of 100 diameters. The stapedial mucosa is seen at the bottom. Fibroblasts extend superiorly to the exudate, and *x* shows the position of capillary blood vessels. *C* shows the gram-positive long chain streptococci from the exudate; × 450. *D* shows the greatly congested drum; × 13.

Summary.—The salient features of the 7 cases are summarized in the table. The first 2 cases were examples of a foreign body exudate in the middle ear of the fetus caused by the presence of the solid constituents of amniotic fluid. The third, fourth and fifth cases were examples of acute purulent otitis media in the new-born infant following

premature rupture of the amniotic sac, with and without associated aspiration pneumonia. In the sixth case the unilateral acute purulent otitis media, not ostensibly related etiologically to delivery, was the focus for purulent meningitis and bilateral labyrinthitis. The last case was one of a metastatic agonal infection of the middle ear in the presence of an organizing exudate, originally either an inflammatory or a foreign body reaction.

REVIEW OF THE LITERATURE

The literature on this subject for the most part is found in articles dealing with otitis media in early infancy and is too voluminous to review in full. A well arranged, extensive abstract of the literature to 1906 is found in Gomperz' monograph.[6] Credit for the first demonstra-

Summary of Seven Cases

Case	Weight, Gm.	Status	Membrane Ruptured, Hours	Cause of Death	Autopsy, Hours Post Mortem	Middle Ear: Cornified Cells	Middle Ear: Cellular Exudate	Middle Ear: Bacteria	Diagnosis
1	2,600	Stillborn	¼	Asphyxia	44	+	+	—	Foreign body reaction
2	4,200	Stillborn	9	Asphyxia	4	+	++	—	Foreign body reaction
3	3,150	Died, 8 hr.	6	Pneumonia	12	+	++	+	Bilateral acute purulent otitis media
4	2,700	Died, 2 da.	21	Trauma at birth	16	+	++++	+	Bilateral acute purulent otitis media
5	3,450	Died, 2 da.	24	Pneumonia	53	++	++++	+	Bilateral acute purulent otitis media
6	2,500	Died, 6 da.	⅔	Meningitis	12	—	++++	+	Unilateral acute purulent otitis media
7	3,450	Died, 22 da.	2	Pyemia; erysipelas	17	—	+++	+	Agonal otitis media

tion at autopsy of pus in the middle ear should go to Koppen,[9] who in 1857, among 14 cases, described pus in the middle ear of a stillborn fetus and of an infant who died on the seventh day. Aschoff [1b] was among those who distinguished the so-called otitis media of the new-born from purulent otitis media of infancy, insisting that pus in the middle ear of the new-born infant, while not physiologic, is the result of contamination by impurities aspirated in the uterus. Gomperz [6] made serial otoscopic examinations of 241 new-born infants and in many found evidence of inflammation which cleared up by the ninth day. In histopathologic studies of the ear of the infant Voss [10] found evidence

9. Koppen, W.: Beobachtungen über Ansammlung von Flüssigkeit in der Trommelhöhle Neugeborner, Inaug. Dissert., Marburg, C. L. Pfeil, 1857.

10. Voss, O.: Klinische und pathologisch-anatomische Folgeerscheinungen geburtstraumatischer Schädigungen des Felsenbeines, Monatschr. f. Kinderh. **34:** 568, 1926.

of small hemorrhages which he thought predisposed to secondary infection of the middle ear.

Hněvkovský [11] in 1883 showed by experiments in submersion that fluid enters the middle ear, even after death, by diffusion and capillary attraction, and Hellendall [4] in 1906, by the same methods, traced fluid to the stomach, smallest bronchi and tissue of the lungs. Also, by means of cultures in cases of premature rupture of the amniotic sac (cases 8, 9 and 10) Hellendall traced bacteria from the placental amniotic fluid to the stomach and lungs, while cultures of the infants' blood were sterile. It is therefore unnecessary to cite the theories of physiologic intra-uterine respiratory movements to explain the early presence of cornified cells in the respiratory tract.[8]

In relatively recent articles concerning otitis media neonatorum authors have mentioned misconceptions of fifty years ago. Asherson [12] said: "In the newborn, the tympanum is filled with gelatinous material." Dodds [13] adhered to the disproved theory that the middle ear at birth is completely filled with embryonal mucosa which is compressed after birth to form an actual cavity by the entrance of fluid or air with the first acts of deglutition.

The following reports of cases of primary purulent otitis in the new-born are cited from the literature without pretext of complete survey: 1 by Habermann,[14] a purulent staphylococcic infection in an infant dying on the tenth day; 1 by Simmonds [15] (case 141) of unilateral purulent otitis media due to a mixed infection, with death on the tenth day; 1 by Weiss,[16] of infection with Streptococcus pyogenes, proved by culture but not in tissue stains, in an infant dying on the second day; 1 by Preysing [17] (case 1), of unilateral pneumococcic infection of the middle ear in an infant dying on the fifth day, and 1 by Mahu and Chomé,[18] of an infection, giving a mixed bacterial culture, without pus

11. Hněvkovský, J.: Das Schleimhautpolster der Paukenhöhle beim Fötus und Neugeborenen und die Wreden-Wendt'sche Ohrenprobe, Wien. med. Bl. **6**: 988 (Aug. 9); 1021 (Aug. 16) 1883.

12. Asherson, N.: Acute Otitis in Infancy, Arch. Dis. Childhood **7**:159 (June) 1932.

13. Dodds, G. H.: Otitis Media with Purulent Meningitis in an Infant Nine Days Old, Arch. Dis. Childhood **6**:71 (Jan.) 1931.

14. Habermann, F. J.: Zur Pathogenese der eitrigen Mittelohrentzündung, Arch. f. Ohrenh. **28**:219, 1889.

15. Simmonds, M.: Ueber Mittelohrentzündung im frühen Kindesalter, Jahrb. d. Hamburg. Staatskrankenanst. **4**:525, 1896.

16. Weiss, S.: Zur Aetiologie und Pathologie der Otitis media im Säuglingsalter, Beitr. z. path. Anat. u. z. allg. Path. **27**:113, 1900.

17. Preysing, H.: Otitis media der Säuglinge, Wiesbaden, J. F. Bergmann, 1904.

18. Mahu and Chomé, E.: Les infections de l'oreille moyenne chez le noveauné, Gynéc. et obst. **6**:313 (Nov.) 1922.

in the middle ear of an infant dying intra partum, the membranes having been ruptured for forty-eight hours. Von Reuss [19] observed a case of bilateral otorrhea in an infant a few days old, and Asherson [12] obtained pus by myringotomy from an infant 1 day old.

Otitis media in the new-born infant, presumably of metastatic origin, was noted by Schwartze [20] (case 2) and Simmonds [15] (cases 93 and 140).

Death on the fifteenth day, of purulent otitis media, sinus thrombosis and embolic pneumonia, occurred in a case reported by Wreden [21] (case 32).

Two cases of otitic meningitis in the new-born have been noted. Bonhoff and Esch [22] reported the case of an infant who died on the fourteenth day of purulent meningitis secondary to purulent otitis media on one side, and Dodds [13] reported the case of an infant who died on the ninth day of purulent meningitis, with unilateral purulent otitis media and greenish pus in the necrotic bone of the medial tympanic wall. Mixed cultures were obtained from the middle ear and meninges.

Crowe [23] described the histopathology of labyrinthitis secondary to meningitis.

COMMENT

The finely to coarsely granular material in the perilymph adjacent to the secondary tympanic membrane (figs. 1*A*, 4*A* and 5*B*) and in the vestibule adjacent to the foot plate of the stapes (figs. 7*A* and *C*) was present in new-born infants in numerous cases in which there were no clinical or pathologic evidence of infection, and I therefore do not consider this material in the new-born as a sign of inflammation.

Various logical theories of etiology have been suggested for the presence of infectious otitis media in the first days of life (transplacental infection; contamination by, or aspiration of, infectious material during passage through the birth canal), and in certain instances they are possibly correct. The conclusion that purulent otitis media in cases 3, 4 and 5 was related etiologically to long rupture of the fetal membranes is based on the analogy of my unpublished confirmation of the conclusions of Johnson and Meyer [5b] that premature rupture of mem-

19. von Reuss, A.: Diseases of the Newborn, New York, William Wood & Company, 1920, p. 369.

20. Schwartze, H.: Beiträge zur Pathologie und pathologischen Anatomie des Ohres, Arch. f. Ohrenh. **1**:195, 1864.

21. Wreden, R.: Die Otitis media neonatorum vom anatomisch-pathologischen Standpunkte, Monatschr. f. Ohrenh. **2**:113 (Sept.) 1868.

22. Bonhoff, H., and Esch, P.: Ueber einen Fall von Meningitis purulenta beim Neugeborenen infolge rechtseitiger eitriger Mittelohrentzündung, Ztschr. f. Geburtsh. u. Gynäk. **70**:886, 1912.

23. Crowe, S. J.: Pathologic Changes in Meningitis of the Internal Ear, Arch. Otolaryng. **11**:537 (May) 1930.

branes occurred in the case of most infants dying of pneumonia in the first four days of life. Early involvement of the middle ear in all of the cases of intra-uterine aspiration pneumonia in my series (with 5 infants dying within forty-eight hours of delivery, with the membranes ruptured for from five to forty-eight hours) and the extent of the exudate in case 4 without gross pathologic evidence of pneumonia suggest that infection of the middle ear also occurs in intra-uterine life and is not merely secondary to generalized respiratory infection. The frequency with which contents of the amniotic sac are found in the middle ear indicates a pathway which is easily traversed.

CONCLUSIONS

The middle ear of the fetus at term may be the site of a foreign body inflammatory reaction due to the presence of the constituents of the amniotic fluid.

Following premature rupture of the amniotic sac, the middle ear of the new-born infant as early as eight hours following delivery may contain masses of pus cells and bacteria.

Otitic meningitis with secondary purulent labyrinthitis may cause death as early as the sixth day of life. The infection presumably occurred postnatally in the case reported here.

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THE VESSELS OF THE STRIA VASCULARIS

WITH SPECIAL REFERENCE TO THEIR FUNCTION

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A fibrous layer, for which I propose the name "stratum fibrosum striae," separates the epithelium of the stria vascularis from the spiral ligament (figs. 1, 2, 4 and 5). This fibrous layer is much thicker in the upper middle and apical turns than it is in the basal turn of the cochlea. At all levels some of the fibers of the basilar membrane which extend into the spiral ligament curve upward and merge with the stratum fibrosum striae; indeed, in the apical turn all fibers of the basilar membrane seem to merge with this membrane. The stratum fibrosum striae is described in anatomic literature as a part of the spiral ligament. Fischer [1] has even given this layer a special designation, "zone 3 of the spiral ligament." However, histologically it differs markedly from the spiral ligament and in extent it corresponds exactly with the epithelial portion of the stria (fig. 1). Embryologically, as was pointed out by Shambaugh [2] and others, the deeper epithelial cells of the stria are mesodermal in origin while the more superficial cells come from the otic vesicle and are ectodermal in origin. For these reasons it seems logical to regard the fibrous layer separating the epithelium of the stria from the spiral ligament as an integral part of the stria vascularis.

Specimens prepared by injecting an opaque substance into the blood vessels and clearing the specimens, such as used by Eichler,[3] Siebenmann [4] and others, show that the blood supply for the stria and the spiral ligament consists of from thirty to thirty-five small arteries which originate in the modiolar region and arch over the scala vestibuli at irregular intervals. They also show that the veins from this region of the cochlea pass along the wall of the scala tympani to reach the modiolus.

From the Otological Research Laboratory, The Johns Hopkins University.

1. Fischer, J.: Der feinere Bau des Ligamentum spirale, Ztschr. f. Hals-, Nasen- u. Ohrenh. **11**:1, 1925.

2. Shambaugh, G. E.: Ueber die Herkunft der in der tieferen Schicht der Stria vascularis sich findenden Zellen, Ztschr. f. Ohrenh. **53**:301, 1907.

3. Eichler, O.: Anatomische Untersuchungen über die Wege des Blutstromes im menschlichen Ohrlabyrinth, Leipzig, S. Hirzel, 1892.

4. Siebenmann, F.: Die Blutgefässe im Labyrinth des menschlichen Ohres, Wiesbaden, J. F. Bergmann, 1894.

Within the stria vascularis blood vessels are seen at two levels. The relations of the more superficial vessels (fig. 1) to the epithelial cells of the stria have been studied by many investigators. The deeper vessels are larger and either run in or are firmly attached to the stratum fibrosum striae (fig. 2). Except so far as these larger vessels are the source of the more superficial capillaries, their distribution and possible

Fig. 1.—All blood vessels in this section of the stria vascularis are of the superficial type; i. e., they lie entirely within the epithelial portion. Note the structure and extent of the fibrous layer beneath the epithelium.

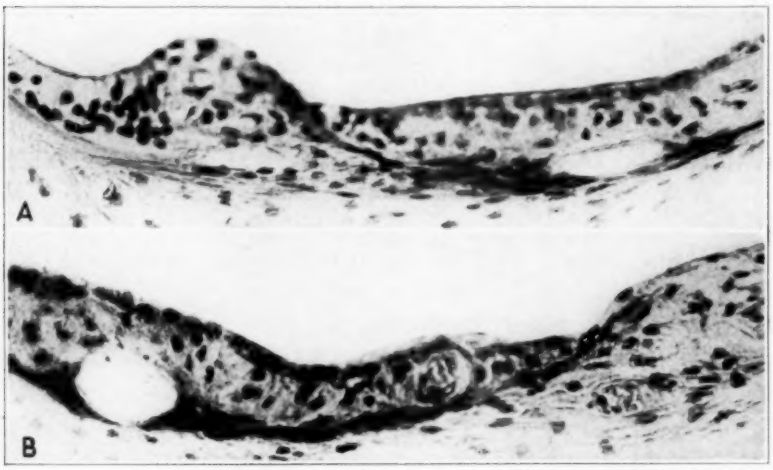

Fig. 2.—*A* shows radiating fibers of the basilar membrane passing beneath the spiral prominence and merging with the stratum fibrosum striae. Note the relation of the deep vessel to the fibrous layer. *B* shows the firm attachment of a large deep vessel of the striae to the stratum fibrosum striae.

function have received no special attention. The arterioles and venules in the stria vascularis are so similar in appearance that it is frequently impossible to differentiate between them in single sections. In serial sections, however, their connections may be traced, and in this way the vessels in the stria can be identified as arterial or venous.

A graphic reconstruction of the larger vessels in the stria of a child, aged 10 months, is shown in figure 3: (*a*) the middle third of the lower basal turn; (*b*) a portion of the upper basal turn. In this reconstruction the distance between the two parallel lines represents the width of the stria vascularis; i. e., from its scala vestibuli margin (*Vest.*) near Reissner's membrane to its scala tympani margin (*Tymp.*) at the level of the spiral prominence. The vessels shown as crossing the lower line (*Vest.*) are branches of the arteries which arch over the scala vestibuli from the modiolar region. These vessels enter the stria by penetrating the stratum fibrosum striae. The solid lines represent vessels which, after entering the stria, course in the deeper layer in contact with the stratum fibrosum and give off capillary branches but leave the stria when still of arteriolar caliber. The broken lines represent vessels

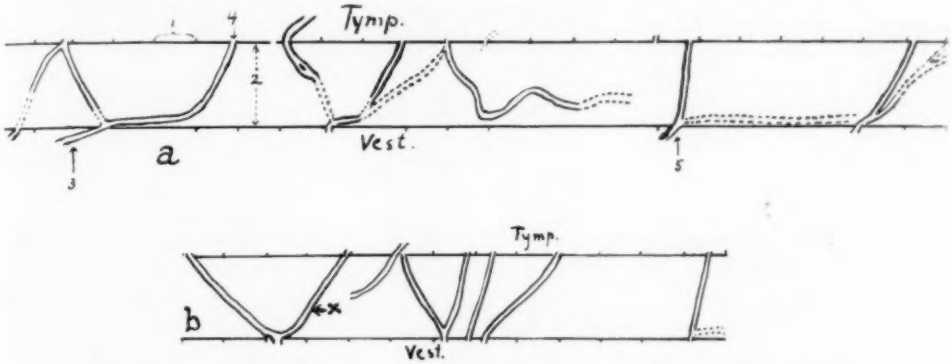

Fig. 3.—A graphic reconstruction of the larger vessels in the stria of a child, aged 10 months: (*a*) the middle third of the lower basal turn; (*b*) a portion of the upper basal turn. For further description, see the text.

which are not attached to the stratum fibrosum but are surrounded by epithelium; some of these more superficial arterioles terminate within the stria. To avoid confusion, neither the veins nor the capillaries are represented in this reconstruction.

Photomicrographs of the arterial vessel marked *x* in the diagrammatic representation in figure 3*b* are reproduced in figure 4: *A* shows the vestibular margin of the stria, the attachment of Reissner's membrane, and the blood vessel entering the stria; *B* shows the same vessel attached to the stratum fibrosum striae and a capillary branching off into the epithelial part of the stria; *C* shows the same vessel still attached to the stratum fibrosum striae at the point where it leaves the stria, just above the spiral prominence. The identification of these larger vessels leaving the stria vascularis as arteries rather than as veins is based on tracing their course in serial sections.

Before Corti, Reissner or Deiters described the structures that now bear their names, Todd and Bowman [5] regarded the spiral ligament as containing muscular tissue which serves to adjust the tension of the lamina spiralis membranacea (now known as the basilar membrane). While their idea of a muscular tissue has not been accepted, many later authors have suggested the possibility that there exists within the cochlea itself a mechanism of accommodation which responds reflexly to

Fig. 4.—Photomicrographs of the arterial vessel marked *x* in figure *3b*. For further explanation see the text.

stimulation by sound. Other authors have pointed out that variations in the degree of filling of the blood vessels of the strial region might influence the form and volume of the cochlear duct (Kolmer [6]). Gray [7]

5. Todd, R. B., and Bowman, William: The Physiological Anatomy and Physiology of Man, Philadelphia, Lea & Blanchard, 1850, p. 455.

6. Kolmer, W., in von Möllendorf, W.: Handbuch der mikroskopischen Anatomie des Menschen, Berlin, Julius Springer, 1926, vol. 3, p. 348.

7. Gray, A.: The Otosclerosis Problem, J. Laryng. & Otol. **49**:629, 1934.

suggested that sound may, by a nervous vasomotor reflex, cause an increased flow of blood to the inner ear.

It is certainly an unusual anatomic arrangement for blood vessels to enter a capillary field and emerge as arterioles, as they do in the stria vascularis. I suggest that this may be part of an accommodation mechanism which responds directly to stimulation by sound. Accommodation is visualized as mechanical, rather than as due to a nervous reflex arc; it depends on the relations of the blood vessels of the stria and of the radiating fibers of the basilar membrane to the fibrous layer (stratum fibrosum striae) of the stria vascularis. The vessels enter and leave the stria by passing obliquely through the fibrous layer, and the fibers of the basilar membrane merge with this fibrous layer. Movements of the basilar membrane, by pulling on this fibrous layer, may possibly produce mechanical constriction of the arterioles at the point of their emergence from the stria. Such constriction of the arterial vessels leaving the stria would cause immediate distention of all vessels in the stria vascularis. The vascular distention would cause a change in the distribution of the intracochlear fluid pressures. The end-result of this series of hypothetic events would be the adjustment of the tension of the basilar membrane to that best adapted for perception of the sound serving as the stimulus.

Clinical Notes

CAVERNOUS HEMANGIO-ENDOTHELIOMA OF THE NOSE

LAWRENCE J. LAWSON, M.D., EVANSTON, ILL.

Descriptions of verified instances of cavernous hemangio-endothelioma of the nose are rare in the literature, and little mention is made of the condition in standard textbooks. It was rarely mentioned in the literature until described by Crowe and Baylor [1] in 1923. The growth arises from the ethmoid region in the lateral wall of the nose and is benign to the extent that it seldom forms metastases. It grows slowly. It is dangerous because of its highly vascular structure and because it grows by infiltration and is destructive to surrounding tissues. It may eventually fill the nose, invade the sinuses and the nasopharynx and finally erode the bony walls of one or more of these cavities. Nasal obstruction and severe profuse epistaxis are common symptoms. Facial disfigurement or exophthalmos may be present. In two patients mentioned by Barnes [2] there was erosion of the anterior wall of the frontal sinus, and a tense, nonfluctuating swelling had been diagnosed lipoma.

Tumors of this type are sometimes soft, are slightly lobulated and may be dark purplish. Their classification as angiomas is justified by their clinical history, the absence of metastases to glands, their involvement of cranial nerves and their invasion of the orbit or the intracranial region. Angiomas of the nose and pharynx are classified [3] according to the type of basal cell and the variety of vessels contained. The framework is usually endothelial though it may be lymphoid. The growth arises, according to Shea,[4] from the most vascular part of the nose, having its attachment to the membrane in the region of the sphenopalatine foramen. The internal maxillary artery at this location divides into its terminal branches and gives a wonderful opportunity for blood vessel tumor formation.

There is considerable confusion in the nomenclature. The same tumor may be diagnosed by different pathologists as angioma, angiosarcoma, hemangio-endotheliofibroblastoma, capillary hemangio-endothelioma and vascular fibroblastoma. This diversified nomenclature makes it more difficult to trace verified instances of tumor of the lateral nasal wall in contrast to the less important septal hemangioma. Various diagnoses result because of the relative rarity of the condition,

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From the Department of Otolaryngology of the Evanston Hospital and Northwestern University.

1. Crowe, S. J., and Baylor, J. W.: Benign and Malignant Growths of the Nasopharynx and Their Treatment with Radium, Arch. Surg. **6**:429 (March) 1923.

2. Barnes, H. A., in Jackson, C., and Coates, G. M.: The Nose, Throat and Ear and Their Diseases, Philadelphia, W. B. Saunders Company, 1929.

3. Oldfeldt, C. C.: Angioma of the Nasal Cavity, Ztschr. f. Hals-, Nasen- u. Ohrenh. **30**:145, 1931.

4. Shea, J. J.: A Report of Two Intranasal Angiomas, and an Unusually Large Antral Polyp, Tr. Am. Laryng., Rhin. & Otol. Soc. **36**:465, 1930.

because specimens of tissue are traumatized or insufficient in size or because the histologic picture is altered by previous radium therapy and infection. The telangiectatic angioma or vascular nevus is well known. The elongated tortuous vessels and the large spaces filled with blood known as cavernous hemangioma are not confusing. These two conditions are held by pathologists as not true tumors. When one studies true tumors arising from proliferation of blood vessels many names are encountered. In a case of tumor of the blood vessels in which the fibrous tissue must keep pace with the rapidly forming new vessels, frequently it is difficult to tell which is the actually growing cell, the endothelial or the supporting cell. Dr. Mallory [5] stated that he was aware of only two blood vessel tumors having metastatized. The endothelial cells are in most instances abnormal in size and shape, and to prove that the endothelium arises from the endothelium of the blood vessels is difficult and at times impossible. Many times definite proliferation can be noted. The abnormality and proliferation of endothelial cells have led to a preference of the term "hemangio-endothelioma."

In the case cited by Sharp and Hansmann [6] L. W. Dean snared off a mass 3 by 1.2 cm., cauterized the base with the electric cautery and later treated the site with 200 milligram hours of radium. The pathologist reported thin-walled capillary-sized vessels lined with endothelium of varied morphology and along the sides of the vessels branching cells showing mitotic figures. This led to the diagnosis of *capillary* hemangio-endothelioma. Sharp and Hansmann found reports of but few such tumors in reviewing the literature. Knauer [7] reported a capillary hemangio-endothelioma arising from the right middle turbinate. In reviewing the literature reports of two acceptable hemangio-endotheliomas were found: One, reported by Roth,[8] arose from the right middle turbinate and ethmoid region, and one, reported by Schreiber,[9] which invaded the orbit, resulting in panophthalmitis and death. Gerber [10] reported a tumor of the nose in a boy which was diagnosed hemangio-endotheliofibroblastoma by Mallory and which disappeared after being treated with 200 milligram hours of radium. Verhoeff and Finck [11] of the Massachusetts Eye and Ear Infirmary reported two tumors similarly diagnosed; both tumors were removed surgically, and radium therapy was later instituted. There were no recurrences.

It is apparently not an uncommon experience [12] in surgical treatment of blood vessel tumors to have the growth gradually recede and finally disappear after partial extirpation alone. This is thought to be due to the fact that the portion removed may contain the primary point of origin or nucleus of the growth.

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5. Mallory, cited by Sharp and Hansmann.[6]

6. Sharp, B. S., and Hansmann, G. H.: Capillary Hemangio-Endothelioma of the Nose, Arch. Otolaryng. **1**:612 (June) 1925.

7. Knauer, Ilse: Ueber einen Fall von kapillarem Hemangio-Endotheliom in mittleren Nasengang mit besonder Berücksichtigung seiner Genese, Arch. f. Ohren-Nasen- u. Kehlkopfh. **105**:14, 1920.

8. Roth: Ueber einen Fall von blutendem Septumtumor, Arch. f. Laryng. u. Rhin. **16**:525, 1904.

9. Schreiber, Gertrud: Ein Fall von Adenoma endotheliale von Hansemann (Hemangio endothelioma intravasculare Borst) mit besonderer Berücksichtigung seiner Histogenese, Ztschr. f. Krebsforsch. **9**:579, 1910.

10. Gerber, I., cited by Sharp and Hansmann.[6]

11. Verhoeff and Finck, cited by Sharp and Hansmann.[6]

12. Crowe and Baylor.[1] Kryze, B.: Angioma of the Ethmoid Region, Časop. lék. česk. **63**:270, 1924.

The treatment may be either by surgical removal or by radium, the latter being preferable in some instances because of the profuse hemorrhage from surgical removal, especially with the cavernous types. Irradiation [13] may effect a marked decrease in the size of the growth, corresponding disappearance of the symptoms or even the complete disappearance of the tumor.

REPORT OF A CASE

History.—Mr. A. R., aged 59, came for examination because of increasing obstruction and recurring severe hemorrhage in the right side of the nose. The right nostril was completely filled to the vestibule with a semisolid, slightly ulcerated tumor. For eight weeks previous to examination nasal hemorrhage had been increasing until there was evident severe loss of blood. The referring physician stated that the tumor had seemed to develop rapidly in the preceding four weeks. Transillumination revealed a dark right antrum and ethmoid region. Films of the sinuses revealed filling of the right side of the nose, the right antrum and the

Note the presence of tumor tissue in the right nasal cavity, antrum and ethmoid region.

right ethmoid region. Thirteen months previous to this examination Dr. Herman Kretschmer, of Chicago, performed an exploratory operation on the bladder and found a carcinoma of the bladder too extensive to remove.

Operative Record.—With the area under cocaine and epinephrine anesthesia the polypoid semisolid extension of the tumor was removed with a heavy snare wire. It had a hard, broad base, and bleeding was very profuse and welled out from a dozen large pulsating vessels. A previously prepared half-inch petrolatum-oiled iodoform gauze packing was quickly placed, the bleeding controlled and further surgical procedure abandoned. The tumor was of such size as to fill the right nostril from the region of the middle turbinate to the vestibule and was semisolid. Removal of the pack after twenty-four hours was not followed by recurrence of the hemorrhage.

Pathologist's Report.—Microscopic section revealed anastomosing strands and small solid masses of plump endothelial cells separated by an edematous stroma.

13. Rosenthal, M.: Hemangioma of the Nose, Laryngoscope **35**:54, 1925.

Small lumens were present in large number, and most of them contained protein substance and a few leukocytes. Some of the larger vessels contained blood. No mitotic figures were found in the endothelial cells. The surface was covered partly by squamous epithelium and partly by exudate.

Diagnosis.—The diagnosis was chronically inflamed cavernous hemangio-endothelioma.

Subsequent Course.—There was gradual recession of the tumor until death one year later from carcinoma of the bladder.

COMMENT

Cavernous and capillary hemangio-endotheliomas of the nose originating from the lateral wall are relatively rare.

Surgical excision should not be attempted without preparation for the emergency of hemorrhage uncontrollable by the usual measures.

Radium therapy is of proved value.

Recession after partial surgical excision alone is not uncommon.

Untreated, these tumors become infected, ulcerate and bleed profusely and may cause death by invasion of the orbit, sinuses and intracranial cavity or by exsanguination.

PULMONARY METASTASIS FROM HYPERNEPHROMA, WITH ULCERATION INTO A BRONCHUS SIMULATING PRIMARY BRONCHIAL CARCINOMA

REPORT OF A CASE

CHARLES K. MAYTUM, M.D., AND PORTER P. VINSON, M.D., ROCHESTER, MINN.

Metastatic lesions from malignant growths elsewhere are frequently observed in the lungs, and such lesions may be very extensive without producing signs or symptoms of pulmonary disease.

If such metastatic lesions involve the pleura, effusion may produce distressing symptoms, but so long as the nodules remain in the parenchyma of the lungs they rarely occasion any discomfort. In contrast to this, a small malignant nodule arising in the lumen of the bronchus may produce marked evidence of pulmonary disease because of the occurrence of bronchial occlusion.

The presence or absence of bronchial obstruction is the most reliable criterion for differentiating primary and secondary malignant disease in the lungs, and yet it has been pointed out that growths that are secondary in the lungs may ulcerate through the wall of the bronchus and cause partial bronchial obstruction, with the production of the signs and symptoms that are seen in growths that arise in the bronchus primarily.

In the present case, a metastatic lesion in the lumen of the bronchus had arisen from a hypernephroma, as had also happened in a case reported previously.[1]

From the Division of Medicine, the Mayo Clinic.

1. Vinson, P. P., and Martin, W. J.: Pulmonary Metastasis from Hypernephroma Diagnosed by Bronchoscopy, Arch. Otolaryng. **15**:368 (March) 1932.

REPORT OF A CASE

A painter, aged 63 years, came to the clinic on Feb. 22, 1935, complaining of shortness of breath of two months' duration. Prior to the onset of this condition he had considered himself to be in good health, although about a year before admission he had been told that he had a "floating kidney."

In December 1934 he had noticed pain in the muscles of the left side of the thorax and left shoulder. This pain had gradually become more severe, and motion of the shoulder had become extremely painful. Strapping the chest had afforded some relief. Early in January coryza had developed, and some fever and constitutional symptoms had been present. Two days later the patient had

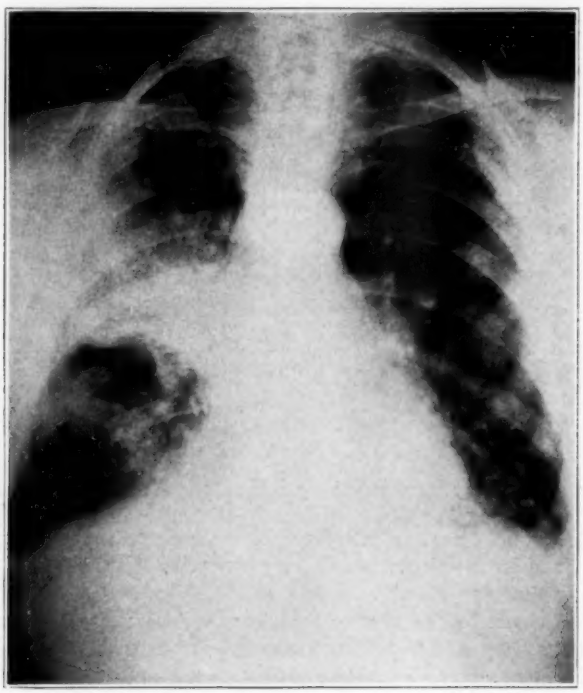


Fig. 1.—Dense infiltration of the middle portion of the right lung and multiple circumscribed areas in the left lung. There is involvement of the pleura on the left with a suggestion of fluid at the base of the left lung.

begun to cough and had raised small amounts of thin purulent sputum. After about a week the sputum had become blood-tinged. The cough had then become more severe, and in the month prior to his admission he had coughed almost continually, raising small amounts of frothy, blood-streaked sputum. Dyspnea had appeared with the cough and had become progressively worse, being rather severe on the slightest effort and being accompanied by a sense of constriction in the chest. Weakness was a prominent symptom, although the patient had lost only 8 pounds (3.6 Kg.). There had been no significant gastro-intestinal or genito-urinary symptoms.

On examination, the patient appeared to be moderately well preserved. The marked dyspnea on even the slightest exertion was noted. He weighed 115 pounds (52.1 Kg.), the average normal being 123 pounds (55.8 Kg.). His blood pressure in millimeters of mercury was 130 systolic and 70 diastolic; the pulse rate was 76 beats per minute and the temperature normal. Inspection and percussion of the chest did not reveal any significant change. Many coarse, moist râles were heard over the entire right lung, and there was a definite decrease in breath sounds over the right upper lobe. In the left flank, an irregular rounded mass about the size of a baseball (6.8 cm.) was felt. It was very firm, was not tender, and descended with inspiration. There were no other significant physical findings.

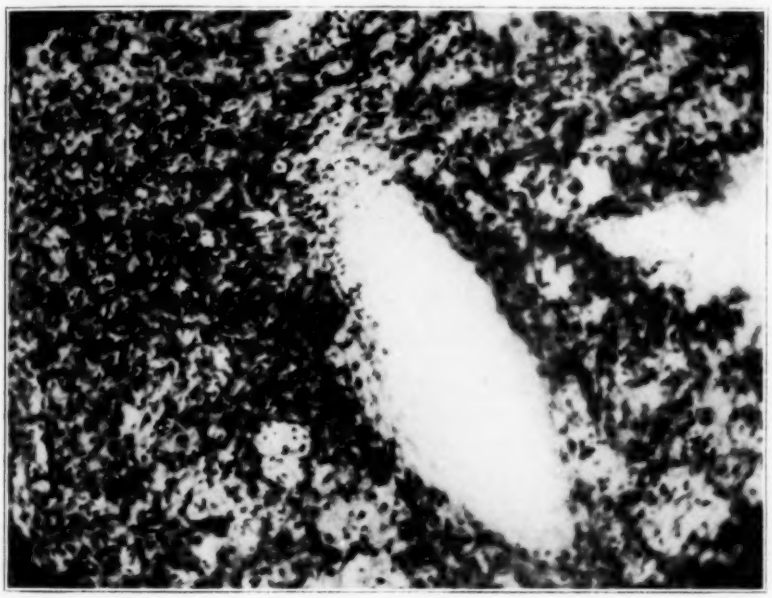


Fig. 2.—Adenocarcinoma, grade 3, of the hypernephroma type.

Examination of the urine and blood did not indicate any abnormality. The flocculation test for syphilis was negative. No bacilli of tuberculosis were found in the sputum (one specimen). Roentgenograms of the thorax revealed dense infiltration of the middle portion of the right lung and multiple circumscribed areas in the left lung. There was involvement of the pleura on the left with a suggestion of fluid at the base of the left lung (fig. 1).

On bronchoscopic examination, a large tumor was observed projecting from the bronchus to the upper lobe of the right lung. When the bronchoscope was introduced the patient coughed out a large piece of soft tissue about 1 cm. in diameter. This was followed by rather free bleeding. After the blood had been aspirated, further study of the bronchial wall revealed a granular base to which the tumor had been attached. Microscopic examination of the tissue showed it to be an adenocarcinoma (grade 3) of the hypernephroma type (fig 2).

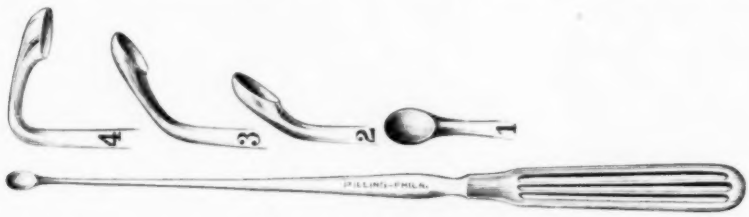
In view of the type of renal tumor found on physical examination, the presence of multiple metastatic lesions in the lung similar to those seen in hypernephroma, and the microscopic appearance of the tissue from the lumen of the bronchus, it was concluded that the renal tumor was a hypernephroma. Further study of the urinary tract was not carried out.

SET OF CURETS FOR USE IN THE SINUSES

C. Calvin Fox, M.D., Philadelphia

A set of four curets is designed for use in surgical work on the paranasal sinuses. They were designed, after experimental study on many anatomic specimens at the Jefferson Medical College, to reach any angle encountered in the sinuses during either a simple or a radical procedure. A similar straight curet has heretofore been available.

Curet 1 is mounted on a straight shank, while the other three are mounted at angles found to be best suited for use in recesses difficult to reach with a short



Four curets for use in surgical work on the paranasal sinuses.

or straight curet. The shanks are rigid and inflexible, in order to prevent any change in the angle or direction of the tip during use, and long and slender, in order not to obscure the line of vision even in the region of the posterior ethmoid or sphenoid sinuses.

The bowls are of the same size and of a shape found to be most universally useful. The cutting edges are arranged to be exactly the same distance from the operator's hand and eye in each instrument, so that in quick changes from one curet to another the depth to which the bowl must be inserted is the same for each curet.

Curets 1, 2 and 3 are adaptable to all the sinuses, while the acute angle of curet 4 was designed primarily to permit one to reach easily the troublesome anteromedial angle of the antrum in performing the Caldwell-Luc operation. The difficulty in cleaning the anterosuperior portion of this angle, with resultant recurrence of disease, was responsible for Denker's extremely radical method.

I have used the original set of these curets for a number of years and have found them of the utmost value in both intranasal and extranasal procedures on the sinuses.

The curets are made by the George P. Pilling & Son Company, Philadelphia.

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology

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FUNCTIONAL EXAMINATION OF HEARING

ROBERT SONNENSCHEIN, M.D.
AND
NORMAN LESHIN, M.D.
CHICAGO

During the past year, or rather during the period from September 1934 to September 1935, a number of papers dealing with audiometry have appeared. As observed during the past few years, it is again true that most of the papers dealing with functional testing of hearing have appeared in the English and American journals and very few in the German or French literature. All in all, the material which forms the substance of this review has not been as extensive during the past few years as was previously the case.

Langenbeck,[1] in a short article, gives a few additional points to supplement a previous article which appeared in the same journal.[2] He calls attention to the fact that Bezold carried out his quantitative hearing tests with the unweighted forks. He evidently did this because the tones of the Edelmann forks were heard longer when the fork was unweighted. The author, however, does not believe that this point is well taken and feels that there is a disadvantage in that unweighted forks have very loud overtones, which are at times more intense than the fundamental tones, making it difficult for the patient to distinguish the latter. If the patient has a long period of hearing, it does not affect him so much, because the overtones disappear before the fundamental tones do. But if a person has a much shortened hearing time, the forks with loud overtones will prove a great source of error.

Langenbeck states it is only with the forks from c-1 (256 double vibrations) upward that the unweighted forks can always be used. A graph is presented showing that the maximum intensity of vibrations of the unweighted forks is somewhat higher than the weighted ones of

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1. Langenbeck, Bernhard: Tuning Forks and Oto-Audion, Ztschr. f. Hals-, Nasen- u. Ohrenh. **37**:173, 1934.

2. Langenbeck, Bernhard: Comparative Value of Tuning Fork and Oto-Audion, Ztschr. f. Hals-, Nasen- u. Ohrenh. **36**:409, 1934.

the same pitch. The author emphasizes the importance of using the acoustic method of training the ears in cases of deafmutism, in which there is a small remnant of hearing by the use of the hearing tube into which words are spoken. With reference to the use of tuning forks or oto-audion in testing, the author believes that there are no essential differences in the two methods.

Robert Bárány,[3] in a rather exhaustive study of the audiometer, discusses the subject largely from a statistical and mathematical standpoint. One of his principal conclusions is that audiometric examinations in general are unnecessary for diagnostic purposes but that for measuring hearing acuity and from a scientific and practical standpoint they are indispensable. He stated also that only by a careful statistical study of the material can the method be brought to its complete fruition. By designating the results in decibels, one obtains a unit which may be used internationally. The purpose of the statistical data submitted is to render aid in the solution of the question, whether changes in the threshold of hearing are a result of chance or whether they are due to some external force or to a change in the pathologic process.

The author also discusses the masking of the ear which is not being examined and points out the difficulties of doing this when bilateral involvement of the middle ear is present.

Bárány discusses the subject of artificial drum membranes made of cellophane. His experiments showed (1) that the prosthesis acts better several hours after its introduction than at first; (2) that it must be in contact with the malleus and that it acts even when the perforation is not completely closed, and (3) that as a rule the hearing for the low tones is improved more than the hearing for the high tones, so that the author believes one may say that the cellophane artificial drum membrane improves sound conduction by way of the ossicular chain. When a cotton pledget saturated with liquid petrolatum is placed in the ear, the high tones are usually amplified more than the low ones.

Yver and Barrat [4] have used at the Marine Hospital at Toulon, France, the audiometer of E. B. Meyerovitz, type G-11, in the examination of soldiers and sailors. They emphasize that for exact measurements of sound three factors must be present, namely: (1) production of pure tones free from harmonics so that there is no possibility of confusion on the part of the patient with reference to the tone used for testing; (2) production of tones of the desired pitch, which may be varied by the examiner, and (3) the ability to increase or to diminish the volume or intensity. The apparatus used by the authors has a range from 64 (ut 1) to 12,288 double vibrations (sol 8).

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3. Bárány, Robert: Audiometric Studies, Acta oto-laryng. **22**:201, 1935.

4. Yver and Barrat: A New Method of Audiometry with Heterodyne, Rev. de laryng. **56**:729 (June) 1935.

The authors state that the presence of good hearing is in many ways a guarantee of the anatomic and physiologic integrity of the ear; also, that one should not be satisfied merely with testing with the whispered voice. Furthermore, in medicolegal matters the audiometer, so the authors say, is employed, especially in America, in order to determine the percentage of the impairment of hearing as the basis for damages in cases of accident occurring during work, etc.

Hulka [5] has written a very complete and comprehensive article on audiometry. He describes the various types of audiometers, their history and their development. The mathematical and physical principles of audiometry are explained. A definition of the various terms used and an explanation as to how their values are obtained are also presented. Various graphs and their interpretation accompany the article. These consist of the sound field, the hearing field of the normal ear and the curves of hearing acuity, including the air conduction and bone conduction curves. The normal hearing acuity is the mean acuity of an arbitrarily selected group of test subjects. This must be differentiated from physiologic hearing acuity, which fluctuates within rather wide limits when measured on a large number of persons. It can even show a wide difference between both ears of the same person. Bunch has reported the age variation, and Drury, the differences in persons of various occupations. Although these physiologic variations have as yet been only superficially investigated, they nevertheless reveal that they may reach into the zone of the pathologic possibilities. The level of the air conduction acuity curve is a definite proof of the existence of a pathologic process only if the loss of hearing in several frequencies exceeds the lower limit of the physiologic possibilities for the age, ear training, intelligence, etc., of the person tested. Under certain conditions the shape of the air conduction curve may indicate the pathologic process. This was shown by Guild and also by Drury. However, this holds true in only a limited number of instances.

Hulka describes the various pathways of bone conduction. Bone conduction tests are for the purpose of obtaining information of the perception apparatus without the action of the meatotympanic mechanism. Although the physiologic variations of bone conduction curves are not definitely known, certain general and approximate rules for their interpretation can be stated. These are for curves obtained on persons in ordinary rooms. The bone conduction curve of persons with healthy ears most frequently is somewhat below normal, less often coinciding with it, and rarely above it. In cases of chronic obstruction in the middle ear the bone conduction curve coincides more frequently with the normal than does the curve obtained on persons with healthy ears.

5. Hulka, I. H.: Present Status of Audiometry, Ann. Otol., Rhin. & Laryng. **44**:544 (June) 1935.

The bone conduction curve in these cases of chronic obstruction may also be higher or lower than the normal. In the case of ears with a closed meatus or those which are filled with a foreign substance or with the middle ear containing an exudate, the bone conduction curves are most frequently above the normal and rarely coinciding with or below it. This effect is not so apparent for tones of high frequency. Persons with impairment of the perception apparatus have lowered bone conduction curves. Some curves show a gradual decline, and others may show a precipitous fall for tones of high frequency. As the age progresses the hearing by bone conduction for tones of high frequency decreases. Severe illness and especially arteriosclerosis cause a more rapid progression of this loss.

The routine Schwabach test as commonly practiced is full of errors. A patient's bone conduction may be called increased when in reality the physician's bone conduction is slightly decreased by the surrounding noise. An older otologist may miss an incipient perception deafness in a young person because both may have a slight decrease of the bone conduction for the tones of lighter frequency. Young otologists with very good acuity of hearing will often diagnose combined deafness when the process in reality may be purely obstructive. Incipient deafness for high tones may not be discovered because of the short period of sounding of high-pitched forks. Audiometric studies seem to indicate that the factor of perception is a much more frequent element in the etiology of hardness of hearing than heretofore realized.

Fowler was the first to offer an interpretation of audiograms by comparing air and bone conduction curves. If all changes in the air and bone conduction curves occur in the sense of decreased acuity as against the normal of the audiogram, the loss of hearing is probably caused by the factor of perception. This factor may not always be pathologic and may mean only a physiologic variation if the losses are commensurable with the average acuity for the patient's age, ear training, etc. If the bone conduction curve shows a slight decrease, is normal or shows a slight increase in one or more of the frequencies while the air conduction curve reveals a considerable decrease in acuity as against the normal of the instrument for these same frequencies, the impairment is probably caused by a disturbance of the conduction apparatus of the ear. When both curves show losses for the tones of high frequency and only the air conduction curve is decreased for the lower range of tones, the impairment is probably caused by a combined obstructive and perceptive lesion. These audiographic diagnostic rules, like the Rinne test, are only approximate methods of determining the etiology of deafness, because one cannot measure the proportion of energy carried by the skull tissues to the cochlea. Furthermore, this proportion may be different for each person tested.

A more definite interpretation of audiograms is possible when the defective ear can be compared with the healthy ear of the same person. It is known that air and bone conduction curves of the same person follow certain similar patterns. This occurs as frequently in persons with healthy ears as in those with ears affected with the identical pathologic process.

The use of instruments of precision, such as the audiometer, for the tests of acuity of hearing has demonstrated the evasive character of the relations of the hearing acuity to the pathologic process in the ear. Its use may not increase the number of diagnoses in general, but it increases the number of correct diagnoses supported by definite facts. In consequence of audiometric researches, in many a case one is further from a definite diagnosis but nearer to the discovery of the scientific truth. This is the main contribution of audiometry to otology. A complete bibliography on audiometry accompanies this comprehensive review of audiometry.

As one of us (R. S.) has repeatedly pointed out in papers on functional hearing tests, and especially with reference to the Schwabach test, it is much better to have an objective standard. It is quite true that if the otologist tests the bone conduction of the patient and does not know definitely whether his own conduction is normal, shortened or lengthened, it is impossible without considerable difficulty to determine definitely the type of bone conduction of the patient who is being examined. If the otologist will test fifty or one hundred persons with the same fork and learn thereby what the average duration of the bone conduction in apparently normal persons is at various ages, he will have a definite standard which is objective and will not need to compare the patient's bone conduction with his own. In early life the bone conduction is quite long; it is less in middle life and much less in old age. We have found this method very effective, and when once the standard is established for the particular fork used, no other criterion need be employed.

Kafka [6] describes an apparatus, which he calls the electro-acusto-testometer, for accurately timing and measuring bone conduction in the Schwabach, Rinne and Weber tests. The instrument is essentially a rubber insulated clamp in which the tuning fork is suspended in such a way as not to interfere with the normal cross-vibrations. The stimulation is controlled by an electromagnet producing the same blow each time. The patient controls the time of stimulation with a push button when he no longer hears the vibrations. This signal also stops the watch. In this way the length of time is automatically registered. The object

6. Kafka, M. Martyn: Electro-Acusto-Testometer for Accurate Timing and Recording of Bone Conduction Test, Laryngoscope **45**:343 (May) 1935.

of this apparatus is to produce a precise and uniform test and a means for accurately timing the bone conduction. This is done by using a uniform stimulation, holding the tuning fork at the same distance away from the ear in the Rinne test, lessening the damping factor by eliminating the holding of the fork with the fingers and using a watch for timing the test. A description and a photograph of the apparatus accompany the article.

Roth [7] devised an instrument which he calls the acoustimeter for testing hearing acuity. This device is an arrangement of tuning forks in series mounted on a revolving base. A hammer, which is actually a pendulum weighted on the free end, is centrally mounted to serve all forks. A stop-watch connected with the pendulum automatically starts when the hammer is released. With this instrument the forks receive a constant force producing a constant maximum intensity and a constant period of decline. An ear-holder keeps the ear at a constant distance from the source of the sound. A sound interrupter is connected with the ear-holder and is operated by means of a handle. This interrupter obviates nerve fatigue and aids the patient in determining the last point of audibility. This combination of mechanical constancies makes a sound-producing device of constant intensities.

Roth also presents a rational charting system which can be interpreted universally. The normal range of hearing for each pitch must be generally agreed on before any chart can be so interpreted. Two fixed points must be known, the upper limit and the lower limit. The lower limit is the point of final audibility, which for measuring purposes must be set arbitrarily. The upper limit has been defined by Fletcher and others as the region at which an additional increase of intensity is appreciated, first as a sensation of tickling and then of pain. This upper limit has been set by experimentation by the telephone laboratories and is used by Roth in his calculations. All the forks on the acoustimeter have been calibrated and their rate of decline determined. When the constant factors are known, the hearing acuity is a ratio between two figures, the numerator being the number of seconds between the upper threshold of hearing and the point of least audibility and the denominator the number of seconds that would elapse if the given fork were made to decline from the arbitrary upper threshold of intensity. Roth explains and illustrates how the calculations are made. Tabulations should also take into consideration the type of room used for testing.

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7. Roth, Aaron: The Acoustimeter: A Device of Tuning Forks with a Graphic System for Charting Acuity of Hearing, Arch. Otolaryng. **20**:571 (Oct.) 1934.

The acoustimeter and the method for making graphs were devised in order to have a system for charting acuity of hearing by means of tuning forks and to construct a mechanical apparatus which eliminates the examiner's ear, which is simple and free from all electrical and intricate elements, avoiding bone or tissue conduction of sound, and which could be produced inexpensively. Professor Knudsen tested the constancy of this device and made suggestions as to the use of a separate reference table of values for convenient and ready use in clinical practice. A chart of values for loss of hearing and percentage of acuity accompanies the article.

Knudsen and Jones [8] stress the necessity for precise hearing tests and measurements in the routine practice of otolaryngology. With these methods, incipient deafness can be discovered. Patients with this type of deafness are the ones who can benefit most from preventive measures. With precision of diagnosis one can determine which patients would benefit from the treatment. It will also enable one to determine the progress of the deafness and help in prescribing the proper types of artificial hearing devices. At present a national committee is working on the standardization of units and scales for the measurement of the intensity of sound. In the near future the decibel will probably become adopted universally as the standard unit for measuring intensity of sound. The writers also show that the human ear is best equipped to the range of the human voice. Under average conditions, except for music, there is little need for acuity of hearing or any hearing at all for the uppermost tones. The average person does not hear higher than about 18,000 cycles, and this is rarely heard when he reaches middle age. At from 30 to 40 years of age the limit is reduced to about 15,000 cycles, and between 55 and 65 the average limit is from 10,000 to 12,000 cycles. At the age of 70 to 75 hearing is rarely above 8,000 cycles.

Knudsen and Jones suggest the use of a chart which shows the "percentage hearing" rather than the loss in decibels. From the standpoint of clinicians it is much simpler and more satisfactory. Tests should be made in a quiet environment. In a noisy room the actual true minimal threshold of audibility cannot be determined. This nullifies the whole test. An accurate measurement of the hearing cannot be obtained unless the deafness is great enough to miss the noise. Tests in a noisy environment determine the amount of noise rather than the acuity of hearing of one's patients. A satisfactory sound-proof booth can be erected for approximately $100. With such a booth early impairment in hearing can be detected.

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8. Knudsen, Vern O., and Jones, Isaac H.: Basic Principles Underlying Tests of Hearing, Laryngoscope **45**:1 (Jan.) 1935.

Reliable hearing tests can be made with tuning forks in a quiet room provided their initial intensity and rate of decrement are known. It is necessary to know the intensity in decibels of each fork immediately after it has received a standard blow. If this is known it is possible to prepare charts for any set of tuning forks measuring only the duration of audibility of the fork and then reading from the chart the loss of hearing in decibels or in percentage hearing at each test frequency. In most cases only three forks are necessary, i. e., those with 128, 512 and 2,048 double vibrations. This is true for air conduction tests. For bone tests the tuning fork is a very limited device. It is impossible to obtain sufficient energy from forks with frequencies above 2,000 cycles to be audible by bone conduction. Bone conduction tests have to be limited to forks of a pitch below 2,000 cycles. With a set of calibrated tuning forks hearing acuity for bone conduction can be determined. These tests should also be performed in a quiet room or booth. The loss of hearing is determined by measuring the duration of audibility of each fork when the stem of the fork is pressed against the mastoid bone. The results should be stated in terms of decibels loss of hearing or percentage hearing. The writers again state that increased bone conduction does not exist. Absolute quiet is highly desirable in testing the air conduction, and it is absolutely necessary in testing bone conduction. The serious limitation of tuning forks is noted in testing the hearing of persons with gross impairment. This is true because the initial intensities of tuning forks are far below the threshold of feeling. With impairment of hearing ranging from 50 to 70 per cent, forks mentioned in the charts, namely, those with frequencies ranging from 128 to 2,048 cycles, may not be heard at all, and the patient is rated as totally deaf.

The vacuum tube devices, such as the audiometer, are far superior to tuning forks in the ordinary noisy rooms which are commonly used for testing. This is so because the ear is covered with the telephone receiver. However, even with these instruments absolute quiet is necessary for bone conduction tests. In testing hearing with the audiometer, hearing acuity for both air and bone conduction should be determined at different frequencies. Voice and whisper tests are carried out with the amplifier part of the instrument. The tests made with the audiometer take much less time, and the results in general are more reliable than those obtained with tuning forks. However, tests made with calibrated forks by a trained person in a quiet environment are more reliable than those made by an untrained technician with the most elaborate audiometer in a noisy room.

The ordinary whisper, voice and ticking watch tests are inadequate for routine tests of hearing. They test only the acuity for high-pitched

sounds and are subject to considerable error, and the intensity depends on the acoustical properties of the entire room. In addition, they cannot be interpreted in terms of absolute units.

Three factors are helpful in making a diagnosis of deafness: the history of the patient, direct inspection of the ear, nose and throat and determination of the condition of those parts that cannot be seen. Routine tests based on the use of the spoken and whispered voice, watch tick, monochord or the tuning fork as commonly used are capable of detecting only gross impairment of hearing and of differentiating between a conductive and a perceptive type of deafness. They are unsatisfactory in mixed types of deafness and in detecting early stages of impairment when treatment may arrest further progress.

To differentiate between conductive and perceptive deafness measurements of the auditory acuity by both air and bone conduction must be made. Air conduction tests in general determine the "over all" characteristics of the organ of hearing. Bone conduction tests enable one to make a fairly direct test of the cochlea since sound vibrations reach the cochlea through a path largely independent of the middle ear. The bone conduction tests become analogous to the study of the fundus of the eye by the ophthalmoscope. It is possible to study bone conduction over only a narrow band of frequencies because tuning forks above 2,000 double vibrations cannot be heard by bone. It is not sufficient to make bone conduction tests at only one frequency; they must be made over several, as is done in tests by air conduction. This makes the test simple and accurate. In most cases three frequencies are sufficient, namely, 128, 512 and 2,048 cycles per second. With suitable bone conduction attachments and a good audiometer, bone conduction tests can readily be made with frequencies up to 4,096 cycles.

Jones and Knudsen [9] again stress the fact that there is no such thing as greater than normal bone conduction or increased bone conduction. This is a fallacy and is due essentially to a masking of a normal person's hearing by the noise in the room. Tests made in the average office present a false standard for the normal. The examiner does not determine his acuity for bone conduction; instead he has measured the noise in the room. These factors must be taken into consideration when making tests. It is far better and simpler to make the tests in a soundproof room or booth, which is almost absolutely necessary for perfection and accuracy.

When the patient is markedly deaf in only one ear and there is a considerable difference in the acuity of the two ears, it is essential to avoid conduction of sound through the head from one ear to the other.

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9. Jones, Isaac H., and Knudsen, Vern O.: Diagnosis of Hearing Impairments, Laryngoscope **45**:24 (Jan.) 1935.

The insulation of the head is about 50 decibels for air conduction but only from 3 to 5 decibels in bone conduction tests. Therefore, in these tests some sort of noise apparatus should be used in the better ear while the other ear is being tested. Any noise apparatus can be used, but it must be not too loud because excessive noise would mask the hearing being tested in the opposite ear.

In the purely conductive type of deafness the bone conduction is normal for all tones. The loss of acuity is greatest for tones of low pitch by air conduction, increasing and becoming normal for tones of very high pitch. In the purely perceptive type of deafness the curves for air and bone conduction are practically alike.

All the defect is within the cochlea, and there is no difference whether the sound reaches it through the middle ear or through the cranial bones. The greatest loss is for tones of high pitch, and the acuity is relatively good for tones of low pitch. In the mixed type of deafness the acuity is best for tones in the middle range, decreasing for both higher and lower tones. The bone conduction curve is normal or nearly so for tones of low pitch but decreases markedly for tones of high pitch, approaching the air conduction curve for tones of very high pitch.

While it is true that tests made in sound-proof rooms are the really accurate ones, from the practical standpoint it is impossible for the vast majority of otologists to have such a room. Most of them practice in large cities where there are many street noises, and most offices do not permit an additional room, especially one built with sound-proof qualities. From a practical standpoint, however, it seems to one of us (R. S.) that since the work is done almost always under noisy conditions, the results are comparable one with the other, even though not quite as accurate as when carried out in a sound-proof space.

Caesar Hirsch [10] suggests using tuning rods for testing the hearing. In most cases the regular routine use of tuning forks for the Weber, Schwabach and Rinne tests, supplemented by the monochord or Galton's whistle for the high tone limit, is adequate. However, in some cases noticed more recently since the World War the impairment is localized more for tones in the high ranges. Slight changes are difficult to ascertain with the usual c-5 and c-4 tuning forks because of their short vibration time. This is remedied with the tuning or sounding rod, which has a much longer period of vibration.

The tuning rod may produce three types of tones: torsion, transverse and longitudinal. The torsion tones are of no practical interest. The transverse tones originate when the rod is struck vertically to its longi-

10. Hirsch, Caesar: Testing the Hearing with Tuning Rods, Eye, Ear, Nose & Throat Monthly **13**:17 (Feb.) 1935.

tudinal axis. The longitudinal tones which are the ones used for testing are obtained by striking the rod on one end. Some transverse vibrations are obtained even with careful frontal stimulation, but these disappear rapidly soon after striking of the rod. The amplitude of vibration of the tuning fork diminishes much more quickly immediately after being struck than does that of the sounding rod. The amplitude of the fork reaches the limit of audibility sooner, but that of the sounding rod fades away much more slowly. Wethlo made the sounding rods of an alloy of aluminum because it has a pure and prolonged longitudinal sound. He dulled the secondary tones by attaching a tube-shaped handle with pieces of leather jammed in between the grip and the rod. Eisenhower and Sonnenschein omitted the leather pads which had a tendency to move and used a three point metal contact. Eisenhower made the sounding rods of a magnesium-aluminum alloy, which does not tarnish and has a long period of vibration. The c-5 rod of Eisenhower and Sonnenschein vibrates between seventy-five and ninety seconds, and the c-6 rod vibrates from thirty to thirty-five seconds. (One of us [R. S.] also recommends the use of the c-6 rod.) The sounding rod is struck with a tiny hammer.

Hirsch used the sounding rod in over 1,500 cases. The advantage is its long period of vibration. This practically eliminates minor inaccuracies of both physician and patient, which are very apt to occur when a tuning fork is used, as the c-5 fork vibrates only about from fifteen to twenty-five seconds. According to Schlittler, the statements of persons with normal hearing varied on the average about three seconds when tested with his sounding rod, which vibrates thirty-five seconds. Young persons report a considerably longer period of hearing than older ones. Hirsch as well as Oberwegner and Truesbach found that persons between 20 and 40 years of age heard their c-5 tuning fork twenty-five seconds, their c-5 sounding rod forty-five seconds and their c-6 sounding rod twenty-six seconds, while those past 40 could hear the c-5 fork and rod twenty-two and forty-three seconds, respectively, and the c-6 rod only twenty-three seconds. In cases of impairment of the inner ear a corresponding shortening of the hearing period for the sounding rod was always found, and in most this diminution ran parallel to the diminution of the hearing for the whispered voice.

At times patients with impairment of the inner ear and only slight diminution of bone conduction give the appearance of simulating deafness. However, when examined with the sounding rod, these patients show the impairment and convince the examiner. In persons with severe conduction deafness good hearing for the sounding rod may still be present; in those with involvement of the perception apparatus a shortening of the hearing period for the sounding rod is found.

Patients with suppurative otitis media frequently show a shortening of the bone conduction and hearing period for the sounding rod. In patients with unilateral deafness for voice, the sounding rod will be heard with the well ear if only the external auditory canal is closed. The healthy ear should be masked with a Bárány apparatus or its equivalent.

The sounding rod can also be used for establishing simulation of impaired hearing. Because of its prolonged vibration, by timing the hearing and repeating it at various intervals, as well as by placing the rod at various distances from the ear, the examiner will soon find out by checking the responses whether the patient is or is not simulating.

Hirsch believes that the c-5 and c-6 sounding rods are better suited for qualitative and quantitative tests than the corresponding tuning forks because of their longer period of vibration. They are of great value to the otologist, who may be unable to afford a complete Bezold-Edelman set or the monochord. Though the rods do not establish a high limit of hearing, the shortening of the hearing period establishes the extent of impairment of the inner ear. These tests with C (64 double vibrations) and a (435 double vibrations) tuning forks enable the otologist to make a satisfactory conclusion in the majority of cases. For the expert they afford a valuable supplement to other tests for diagnosing impairment of hearing both qualitatively as well as quantitatively, and for discovering simulation.

Ernst Bárány,[11] in a short article in which considerable mathematics is employed, discusses the significance of bone conduction in the hearing of air-borne sounds and comes to the conclusion that in normal persons bone conduction plays practically no part in the hearing of air sounds in the range of from 200 to 800 double vibrations. In cases of increasing impairment of the conduction apparatus the hearing by bone conduction has at first no significance; only when, owing to this impairment, there is a reduction of the hearing for air sounds greater by 60 decibels than the diminution in bone conduction does the patient begin to use the bone conduction for the air sounds to a predominating degree.

Ciocco[12] reports the incidence of shortened bone conduction with the normal hearing by air conduction in a group of 907 persons. He also determined the relative distribution of those with both normal and shortened bone conduction as to age, sex, race, otitic disturbances, etc. This phenomenon, namely, decreased bone conduction with normal hear-

11. Bárány, Ernst: The Significance of Bone Conduction in the Hearing of Air Sounds, Acta Oto-laryng. **22**:229, 1935.

12. Ciocco, Antonio: Disproportinate Shortening of a Bone Conduction, Acta oto-laryng. **22**:529, 1935.

ing for air conduction, is sometimes known as Wanner's symptom and was reported by him in 1900. The impression at that time was that this was due to organic changes of the skull or its contents. O. Beck in 1913 gave this phenomenon great significance when he claimed it to be pathognomonic of syphilis. All the authors who have observed this phenomenon in a high percentage of syphilitic persons have failed to report comparable observations on nonsyphilitic persons. The etiology has been considered by some as related to increased intracranial pressure and by others as associated with pathologic changes in the cerebrospinal fluid.

The patients examined were those who came into the hospital with ailments other than those of an otologic nature. The air conduction tests were made with the audiometer, and the c-2 (512 double vibrations) tuning fork was used for the Weber, Schwabach and Rinne tests.

Ciocco found no patient over 69 years of age with normal bone conduction, and only 6 of 47, or 12.8 per cent, who had shortened bone conduction were below the age of 40. In addition, as a group the patients with shortened bone conduction besides being older have a greater impairment for high tones than the average for their age and sex.

Ciocco's statistical analysis of these 907 persons having good hearing for air conduction up to and including 512 double vibrations showed that 58 per cent had normal bone conduction for the tuning fork of 512 double vibrations, 36.8 per cent had slightly shortened bone conduction, and 5.2 per cent, shortened bone conduction. The incidence of shortened bone conduction increases with advancing age. There is no association between the degree of impairment of bone conduction and the following conditions: sex, race, history of otitis media, appearance of the drum membrane, tinnitus, vertigo, syphilis, cardiovascular diseases, disease of the gastro-intestinal tract and intracranial tumors. Nor is there an association with a history of previous attacks of pneumonia or other acute infectious diseases. The lack of correlation of shortened bone conduction associated with syphilis is of special interest. This extensive study shows that age is the only clinical factor associated with this proportionate shortening of bone conduction. Any explanation of this phenomenon must take these facts into consideration.

Taylor [13] emphasizes the possibility of prenatal medication as a causative factor of deafness in the new-born. This subject has received little attention from the otologist. Data on this phase of the subject are scarce in view of the absence of accurate prenatal records, especially when deafness in the child has been diagnosed at 2 or 3 years of age.

13. Taylor, H. Marshall: Prenatal Medication as a Possible Etiologic Factor of Deafness in the New-Born, Arch. Otolaryng. **20**:790 (Dec.) 1934.

If a large number of otologists will include in their questionnaires prenatal histories of the mother, including medication administered and susceptibility to drugs, an etiologic factor for deafness acquired in utero may be established. This type of deafness need not be complete. Quinine takes precedence among the drugs used during pregnancy which may cause nerve deafness. Definite evidence has been shown that thse drugs pass through the placenta and may be toxic to the fetus. This problem is of sufficient importance to warrant the cooperative research of the biochemist, histopathologist, obstetrician and otologist.

Dixon [14] describes a test to determine the percentage of deafness in malingerers. This applies principally to those persons who following accidents are deaf but in an attempt to present a good case overstep themselves in claiming greater loss than they actually suffer. The fundamentals of the test are not new. The patient is blindfolded, and the aural end of the Bowles stethoscope, having 6 inches (15.2 cm.) of rubber tubing attached, is placed in each ear. A nurse stands behind the patient and holds the free ends of the tubing pointed in opposite directions. A ruler projects beyond the tube leading to the normal ear. Two tuning forks of the same pitch (256 double vibrations preferred) are used. The hearing is then determined in the normal ear for this tuning fork. Then both tuning forks, one held in each hand, are stimulated with equal force; one is held 0.5 cm. beyond the end of the tubing leading to the supposedly deaf ear. The range of hearing for the good ear is then determined by approaching the other fork to that ear until it is heard. If both ears are the same the vibrations of the fork leading to the so-called deaf ear will exclude all sound in the good ear until it approaches a distance of from 2 to 3 cm. from the tube. If the range of hearing remains the same in the good ear as it was before applying the second fork to the other ear, then the hearing in the questioned ear is actually lost, and there is no malingering. The range of hearing in the normal ear will vary from about 1 cm. from the tube to its normal range, which was determined at the onset of the test, depending on the degree of deafness of the tested ear.

The advantage of this test is that outside noises are excluded, the sound is intensified through the rubber tubing and the patient is more confused as to the origin of sound with the use of the stethoscope. One is also able to testify on the witness stand, if necessary, with a fair degree of accuracy the presence and the percentage of loss of hearing in a malingerer.

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14. Dixon, Fred W.: A Method to Determine the Percentage of Deafness in Malingerers, Ann. Otol., Rhin. & Laryng. **44**:483 (June) 1935.

Knudsen and Jones [15] discuss the problem of artificial hearing aid. Although perfect instruments cannot solve the problem of the deafened person completely, a great deal can be accomplished with them. It is the duty of the otologist to prescribe these instruments properly as the ophthalmologist prescribes glasses for defects in sight. One must eradicate an almost universal fallacy that the use of artificial aids will injure the hearing and make the patient entirely reliant on them at all times. It has no effect on the hearing except to help it, leaving what natural hearing the person has intact and the same as it was before the aid was used. At present, the most practical and simple device is the one utilizing the component parts of a telephone system, with a microphonic amplifier introduced between the system microphone and the receiver. The introduction of the vacuum tube marked the beginning of a new epoch in the amplification of sound. Instruments with the tubes are now available, but most of them are too heavy and cumbersome. A recent development which meets the requirements of the deafened person for the use of the telephone has been designed by telephone engineers. It is a separate vacuum tube amplifier inserted between the incoming line and the telephone receiver. It has an adjustable volume control. This instrument is leased on the monthly rental basis by the telephone company.

The ideal aid would consist of a microphone free from distortion and adventitious noise, a vacuum tube amplifier providing the required amount of amplification without distortion or noise, a receiver capable of reproducing all audible frequencies without distortion and a sufficient separation between the microphone and the receiver to prevent "howling." This is obtainable today but is not practical because the price of such an instrument is too high and it would not be made easily portable. The price would be about $400, and the equipment would be very bulky, about one-half cubic foot, weighing over 25 pounds (11.5 Kg.). In addition, the microphone and receiver would have to be separated at least 20 feet (6 meters) to prevent "howling."

The devices which have been invented for amplifying sound are limited in the extent to which they amplify, and the portable devices introduce serious distortion. As yet there are no manufacturers or technicians to fill the prescriptions for aids to hearing after the quantitative defect has been determined. Selective amplification has not been generally adopted by the manufacturers of artificial aids. Further investigation of this problem should prove of real value. Wherry reports that he has fitted a number of patients according to prescription providing selective amplification with satisfactory results. Which persons

15. Knudsen, Vern O., and Jones, Isaac H.: Artificial Aids to Hearing, Laryngoscope **45**:48 (Jan.) 1935.

can obtain benefit from an artificial aid? Those with conductive deafness can receive the greatest possible help. Those with pure perceptive deafness not exceeding 50 per cent will derive sufficient help to justify their use. Those with mixed deafness, in which the conductive element may be as great as 50 per cent and the perceptive defect not exceeding 30 per cent, will also receive benefit. If an artificial aid is used in these cases the amplification should not be too great so that the already weakened cochlea is not overstimulated and cause further damage. When loss of hearing is as great as 60 per cent and due to perceptive defect only, the distortion which sufficient amplification would produce offsets the value of the amplification.

If the audiometer is equipped with a microphone, one can determine and demonstrate to the patient whether he will or will not hear well with an artificial aid. If, in addition, it is equipped with electrical filters so that one can produce any degree of amplification for different frequencies, it is possible to find out if the patient can derive benefit from any type of selective amplification.

To prescribe a proper instrument for the patient, Fletcher states that it is necessary to know the audiogram of the patient and the amplification curve of the instruments. It is highly desirable that manufacturers should furnish a certificate describing the amplification characteristics and the noise audiogram of the instrument. The immediate practical solution for the otologist is to make a careful diagnosis and precise hearing measurements and then to repeat these tests with several of the best makes of instruments on the market. Tests of speech articulation similar to those employed by telephone engineers in testing the efficiency of speech transmission should also be employed in determining the efficiency of a hearing aid. The patient sits at a distance of 4 feet (121.9 cm.) from the examiner with the hearing aid connected. The lips are not seen. A list of words containing vowels and then a list of words containing consonants are spoken, and the patient either repeats these or writes them down. A check is made to determine how many of the words are heard correctly.

A large number of patients can be benefited by hearing aids. There are now dependable methods for rating the performance of artificial aids. If the otologist does not accept this responsibility, others will. It is the duty of the otologist to advise these persons with defective hearing properly and to prescribe the correct hearing device for them.

Correspondence

HAY FEVER AMONG THE JAPANESE

To the Editor:—In the January 1935 issue of the ARCHIVES OF OTOLARYNGOLOGY (vol. 21, p. 9) there appeared an article "Hay Fever Among the Japanese: II" by Dr. H. J. Hara. In this article the incidence of atmospheric pollen in Los Angeles and that in Japan are compared, and certain conclusions are drawn from the findings.

The article states that "all pollen was counted" on the slides exposed to the air in California. There was, however, difficulty in identifying pollens on the slides obtained in Japan. Fifteen photomicrographs of these "Japanese pollens" are shown, but of the fifteen at least seven are pictures of spores of rusts and molds. One of them is very evidently Hormodendrum (Cladosporium), and another shows very plainly the mycelium which has grown after the spores fell on the slide.

In view of the fact that an indefinite number of spores of molds have been included, at least in the Japanese figures, and since I often find more spores than pollen on my atmospheric slides, I believe that the principal conclusions of the article are of doubtful accuracy. The difficulties encountered in making a botanical survey at a distance of more than 4,000 miles are appreciated, but the work is meaningless without accurate identification of the spore particles found. It is to be hoped that the slides have been saved and can be reviewed.

O. C. DURHAM, North Chicago, Ill.

Abstracts from Current Literature

Ear

Fistula Auris Congenita. Theodore K. Selkirk, Am. J. Dis. Child. **49**:431 (Feb.) 1935.

The term fistula auris congenita refers to a small sinus of the external ear, which opens most commonly at the anterior border of the ascending limb of the helix. The clinical significance of such a fistula lies in the fact that it can give rise to an offensive discharge, form a retention cyst or become infected. Infection can give rise either to a lesion of the fistula itself or to a lesion of the face in front of the ear. Treatment of the latter type of lesion may be unsuccessful unless the origin in the congenital fistula is recognized.

Selkirk observed 172 cases of fistula located at the anterior margin of the helix. The condition is comparatively common, but it is easily overlooked. Nearly 1 per cent of white school children and about 5 per cent of colored school children presented this type of fistula.

Other types of aural fistulas are discussed.

Nelson Paul Anderson, Los Angeles [Arch. Dermat. & Syph.]

Diagnostic Difficulties in the Convalescent Stage of Mastoidectomy. Morris A. Weinstein and Lewis Merklin, M. Rec. **140**:196 (Aug. 15) 1934.

Weinstein and Merklin give the following summary of their paper:

The temporal bone may be the seat of great danger, particularly in the postoperative stage. When symptoms point to possible complications one should first eliminate by careful examination any possible focus in the operative field. One should not be too hasty to reoperate on small children, because as a rule they present mostly the acute disease, with toxemia as a predominating factor; meddlesome surgery is not only useless but often dangerous. Adolescents and adults present more chronic pathologic conditions and require a more radical approach in appraising them. One should carefully study the patient, his general appearance and his psychic reactions. Much depends on the experience and common sense of the surgeon, for which no rule can be laid down.

Williamson, New Orleans. [Am. J. Dis. Child.]

Methods of Testing and Management of the Deafened School Child. Edmund Prince Fowler, New England J. Med. **211**:364 (Aug. 23) 1934.

Fowler explains the use of the audiometer in testing the hearing of school children (mass testing). The great advantage of the audiometer is that losses of both air conduction and bone conduction may be estimated in the same units of measure (the sensation unit or its equivalent, the decibel).

It can be definitely shown by repeated careful otolaryngologic examinations and audiometric tests that, if properly managed, more than 60 per cent of all children sent to the otolaryngologist following school surveys can be benefited, and that lapses in treatment and management are frequently accompanied by tragic results as to the hearing and also the health.

Gengenbach, Denver. [Am. J. Dis. Child.]

An Analysis of Over Four Thousand Cases of Educational Deafness Studied During the Past Twenty-Five Years. Macleod Yearsley, Brit. J. Child. Dis. **31**:177 (July-Sept.) 1934.

The total number of children analyzed in this study was 4,314, comprising 2,164 boys and 2,150 girls. These were grouped into those with congenital deaf-

ness and those with acquired deafness. The present section of the article concerns only the group with congenital deafness. The data for these are given in the table:

	Boys	Girls
Hereditary deafness	95	115
Sporadic deafness	548	479
Aphasia	27	20
Total	670	614

Hereditary deafness is defined as that which is accompanied by a family history of other persons born deaf either in direct line or in collateral branches. The study of family histories in cases of hereditary deafness shows definitely that hearing appears to be the dominant, and deafness the recessive, character. Nearly all the cases of hereditary deafness in this series illustrate two salient points in mendelianism: the origin of recessives from impure dominants and the "breeding true" of pure recessives. Among the 210 patients analyzed only 11 showed consanguinity (there were 6 instances of the marriage of first cousins, 3 of the marriage of second cousins and 2 in which the degree of cousinship was not stated).

Sporadic deafness at birth is defined as that which is accompanied by a family history of other relatives who have not been born deaf, save those in the same generation, but who may show other defects, mental or physical. In this group there may be instances in which the deafness was acquired in early life and the defect was not detected until as late as the second year of life. When consanguinity is considered in this connection it seems to resolve itself largely into a matter of stock. If the stock is good and free from taint of hereditary deafness there is no reason why the offspring of a consanguineous marriage should show deafness. There were 22 cases of sporadic deafness, in 19 of which there had been marriage of first cousins and in 1 marriage of second cousins; in 2 the degree of consanguinity was not stated. Illegitimacy does not seem to play a significant rôle. Congenital syphilis and intestinal toxemia are also mentioned as possible causes of occasional instances of deafness at birth.

LANGMANN, New York. [AM. J. DIS. CHILD.]

HISTOLOGIC STRUCTURE OF TEMPORAL BONE IN CONGENITAL AND LATE OSTEOGENESIS IMPERFECTA. F. ALTMANN, Monatschr. f. Ohrenh. **69**:448 (April) 1935.

Altmann points out that osteogenesis imperfecta is a disease of the entire skeletal system and becomes manifest in a disturbance of the endochondral as well as of the periosteal ossification. It is essentially the result of a deficient function of the osteoblasts, probably on the basis of a defect of the formative power of the entire mesenchyma. Like the other generalized skeletal diseases, osteogenesis imperfecta becomes manifest also on the temporal bone; and the bony labyrinthine capsule, because of its peculiar development and structure, is well suited for the study of the pathogenesis of the disease. After mentioning several other investigators who have made histologic studies on the temporal bone in cases of osteogenesis imperfecta and after briefly reviewing their observations, Altmann describes his own studies. The first temporal bones studied by him were from a new-born girl with the typical aspects of osteogenesis imperfecta, with changes in the entire skeletal system and with multiple fractures. Following embedding ot the temporal bones in pyroxylin (celloidin) the right one was sectioned vertically and the left one horizontally. The temporal bones showed the changes which are characteristic of osteogenesis imperfecta and which were observable also in the other portions of the skeleton. There were quantitative as well as qualitative changes in the bone formation. The quantitative changes were found in all portions of the temporal bone. The endosteal layer of the bony labyrinthine capsule showed a decrease in mass only in the upper portion of the cochlea. The changes in the periosteal layer were more noticeable, but the endochondral layer showed

the severest changes. Here the reduction in the mass of the bone tissue had resulted in a greater width of the medullary spaces. The reduction in the mass of the bone tissue was more noticeable in the posterior portions of the vestibule and of the semicircular canals than in the region of the cochlea. The author, like Fischer, Weber and Meyer before him, observed that the spaces of the vestibule and of the semicircular canals were surrounded by a layer of extraordinarily compact bone, which was adjoined by the medullary space with its scant and thin trabeculae. The reduction in mass of the endochondral and periosteal bone tissues and the width of the central medullary space were noticeable also on the malleus and the incus. Regarding the qualitative changes, the author says that the fibrillar structure of the endochondral bone tissue corresponds to the strandlike bone tissue and shows a greater abundance of roundish bone cells than is usually the case. However, these changes are not uniform throughout, but are more noticeable on the posterior portions of the labyrinthine capsule, particularly in the region of the semicircular canals, than on the cochlea. Like Fischer and Meyer, the author was able to detect in some parts, particularly in the upper portions of the cochlea, unusually large cartilaginous rests, but he also observed in this region somewhat larger interglobular spaces. In the zones of ossification, he observed, like Meyer, some irregularities in the decomposition of the cartilage. The estimation of the periosteal tissue proved difficult, because it normally undergoes considerable changes during this period of development. The endosteal bone tissue showed almost normal structure. The author calls especial attention to a formation in the anterior portion of the right middle ear, which, on the basis of its histologic structure, must be regarded as an arterial remnant, and he considers it possible that the formation is a remnant of the arteria stapedia. He further describes studies on the temporal bones of a female infant of premature birth (eighth lunar month) with typical osteogenesis imperfecta. In this case, too, there were quantitative and qualitative disturbances in the bone formation. Then, after pointing out that osteogenesis imperfecta appears not only in fetuses but also in children and adults, the author states that Ruttin studied the late form in a patient aged 24, and that he himself was able to study the juvenile form in a child aged 17 months. He gives a detailed description of his histologic studies in this case. In the conclusion he agrees with Bauer, who regarded the congenital form of osteogenesis imperfecta as the defective ossification of the developing bone and the late form as that of the growing bone. He also concurs with Tanturri, who called attention to the greater incidence of osteogenesis imperfecta in females.

EDITOR'S ABSTRACT.

DIAGNOSIS OF TUMORS OF THE ACOUSTIC NERVE. H. BRUNNER, Monatschr. f. Ohrenh. **69**:493 (April); 549 (May) 1935.

This discussion is one of a series which Brunner published under the general heading "Contributions to the Otologic Diagnosis of Brain Tumors." He says that among 115 tumors which he studied in the course of these investigations there were only two groups the localization of which nearly always impaired the cochlear nerve: (1) the tumors of the cerebellopontile angle and (2) the tumors in the region of the mesencephalon. He intentionally does not include tumors of the frontal lobe, for he was never able to find definite proof of a central auditory disturbance in association with even an unusually large tumor of the frontal lobe. He likewise failed to observe central auditory disturbances in association with other tumors of the cerebrum, but an exception to this was a frontotemporal glioma that had proliferated into the ventricle, for in this case both internal ears were affected. However, even in this instance, the hardness of hearing could not be definitely traced to the cerebral tumor. Brunner stresses that, on the basis of his observations, examination of the hearing capacity has only slight significance for the diagnosis of cerebral tumors. He further cites Cushing's opinion about the cochlear symptoms in cases of tumor of the cerebellopontile angle and particularly of the acoustic nerve. He concedes that Cushing's statement is correct when

applied to the most characteristic aspects of such tumors, but he says that there are tumors of the acoustic nerve which are not accompanied by objective aural symptoms, although there may be some subjective ear sounds. He thinks that the subjective ear sounds do not have the fundamental importance ascribed to them by Cushing. He advises differentiation between the median and the lateral tumor of the acoustic nerve, pointing out that the ear sounds associated with the latter develop early, whereas in cases of median tumor the ear sounds frequently develop rather late. He advises against overestimation of subjective symptoms and then gives his attention to objective examination of the organ of hearing. He asserts that in the majority of cases there is normal hearing capacity on the healthy side, but that there are some cases in which the hearing capacity on the healthy side is impaired also. If the impairment of the brain stem due to pressure is disregarded, there are a number of factors that might cause this condition. After discussing these possibilities, the author reaches the conclusion that lateral tumor of the acoustic nerve produces on the diseased side deafness or severe baryecoia, whereas the healthy side has normal hearing or mild or severe baryecoia (almost never deafness). A differentiation from bilateral tumor of the acoustic nerve can be based on the degree of baryecoia and on the retained labyrinthine irritability on the healthy side. There are exceptions to this rule, which the author illustrates by reporting a case. He further shows that the behavior of the hearing capacity is much more complicated in cases of median tumor of the acoustic nerve. He thinks that as a rule the subjective symptoms on the part of the cochlear nerve appear rather late in such cases. They are late not only in relation to the general symptoms of pressure (headache, vomiting, choked disk) but also in comparison with the subjective symptoms on the part of the labyrinth (vertigo). Objective examination discloses in these cases usually remnants of hearing on the diseased side. The author gives his attention to special symptoms, particularly to vertigo and nystagmus. In regard to the latter, he says that in the majority of cases of tumor of the acoustic nerve (not those of tumor of the cerebellopontile angle) the nystagmus is not severe, but rather mild, is directed toward one or both sides, and may be purely horizontal or horizontorotatory. Vertical nystagmus and visual paresis are signs of severe impairment of the brain stem. Further it is pointed out that disturbances in equilibrium, in walking and in pointing are purely neighborhood symptoms; that is, they indicate involvement of adjoining regions. Caloric, rotational and galvanic tests are likewise evaluated, and the diagnostic significance of paresis and paralysis of the facial nerve is discussed. Finally the roentgenologic aspects are reviewed.

EDITOR'S ABSTRACT.

TREATMENT OF CHOLESTEATOMATOUS SUPPURATIONS OF MIDDLE EAR. A. REJTÖ, Monatschr. f. Ohrenh. **69**:544 (May) 1935.

After calling attention to some of the shortcomings of radical surgical intervention in the treatment of cholesteatoma, Rejtö points out that within the last six years he has repeatedly advised against aqueous therapy for cholesteatoma, for the reason that this treatment does not only fail to effect cure but even promotes the further development and causes severe destructions and complications. He further states that Day's experiences corroborated his own observations, and that that author obtained favorable results by syringing with 95 per cent alcohol and with ether. He himself, for the last several years, has resorted to syringing of the antrum alternately with absolute alcohol and with carbon tetrachloride. He emphasizes that the latter substance is suited for the treatment of cholesteatoma because it dissolves not only the cholesterol crystals but also their esters. To be sure, in large doses it is poisonous, but in the quantities in which it is used for the treatment of otic cholesteatoma its toxic influence is of no importance. The small quantities that may reach the pharynx by way of the eustachian tube give the patient an unpleasant taste, but otherwise no harmful effects have been seen in the few cases in which this happened, for, if sufficient care is taken and the

head is held in the right position the irrigating fluid can be prevented from entering the pharynx. In answer to the objection that carbon tetrachloride has a low fatal dose (English pharmacopeia, 1.5 cc.; maximum dose in American pharmacopeia, 2.5 cc.), the author says that the fatal dose of the preparation he used has been given as 5 cc. However, the small quantity that eventually might reach the pharynx is far removed from the fatal dose. Aqueous solutions of carbon tetrachloride are rather ineffective as far as the solution of fat is concerned, and for this reason it is advisable to precede its use by a dehydrating treatment with absolute alcohol. By alternating the treatments with alcohol and carbon tetrachloride, the author first dehydrates and then dissolves the cholesteatoma of the middle ear.

EDITOR'S ABSTRACT.

OTITIS IN INFANCY. LOTAR HOFMANN, Wien. klin. Wchnschr. **47**:434 (April 6) 1934.

Hofmann remarks that the treatment of acute otitis in infancy must be general as well as local. The general treatment consists of rest and nursing care; it is often neglected in the belief that local illnesses must be treated locally. If neglect of general treatment has a harmful effect on otitis in adults, it has a still worse effect in children. Often otitis will not yield to local treatment, and it is observed that the child is feverish, restless at night and in poor general condition. If the child is taken to the hospital it is surprising how, with rest and nursing care, the poor local and general conditions improve. The local treatment depends on the progress of the otitis. In the first twenty-four to forty-eight hours no special measures need be taken, except if there are unusual indications such as meningism. Local luke-warm instillations of phenol in glycerin may be given, and small doses of aminopyrine may be given internally. A good, though expensive, preparation is phenyldimethylpyrazolon. If the otitis is not severe, these measures may suffice; otherwise, paracentesis must be carried out. The author believes this to be a valuable measure, although some physicians are strongly opposed to it. Paracentesis must be undertaken above all in cases of high fever and marked involvement of the tympanic membrane. The fact that paracentesis does not always cause the fever to abate does not diminish the value of this procedure, because usually there is a prompt fall in temperature as well as abatement of other symptoms. That the fever does not always disappear is due to various causes. The paracentesis causes drainage of material from the tympanic cavity and only partially from other parts of the ear and from the mastoid process. If some obstacle, such as a swelling of the mucous membrane, prevents drainage of pus from the antrum mastoideum to the tympanic cavity, a fall of temperature is prevented. It is possible that not much pus may be present, especially if the inflammation is phlegmonous. This possibility must be kept in mind when paracentesis is undertaken too soon. If there is no pus present the opening made by the paracentesis may close, and the procedure may have to be repeated. Another cause of persistent fever after paracentesis may be the presence of some other illness such as pneumonia. After paracentesis free drainage must be obtained either by rinsing or by small gauze strips introduced daily into the ear to the tympanic membrane. If the suppuration becomes fetid, the auditory canal must be kept dry by introducing boric acid after the canal has been cleaned. If mastoiditis develops operative treatment must be undertaken.

ABT, Chicago. [AM. J. DIS. CHILD.]

ANATOMY AND PHYSIOLOGY OF THE CUPULA TERMINALIS IN THE AMPULLA OF THE SEMICIRCULAR CANAL. W. STEINHAUSEN, Ztschr. f. Laryng., Rhin., Otol. (Teil 1: Folia oto-laryng.) **26**:29, 1935.

Steinhausen, after reviewing his method of visualization of the unchanged cupula on the living animal, describes studies on the labyrinth of the pike. He illustrates his description with a diagram of the membranous labyrinth of the

pike. His studies reveal that the cupula is a well formed gelatinous mass. In the life-fresh preparation the cupula is much larger than was formerly assumed. It reaches from the crista to the ampullar roof; that is, it fills the ampulla completely and closes it endolymph-tight. The author was also able to show that the ampulla has the function that is ascribed to it in the Mach-Breuer theory, with the modification that the cupula does not perceive some hydrodynamic pressure in some unknown manner, but that it is actually deviated, and that this change in position produces the stimulus for the sensory epithelia. He shows that if the head is turned to the left there is a deviation of the cupula of the left horizontal semicircular canal toward the utricle (ampullopetal current of semicircular canal). In order that the eyes may retain their fixation point they must be turned toward the right. The author shows further that in the case of a prolonged turning of over 90 degrees the simple deviation of the eyes is not sufficient for fixation, and nystagmus is necessary; that is, a prolonged deviation of the cupula will be followed by nystagmus. However, deviation of the cupula to the other side (ampullofugal current) produces no reaction on the part of the eyes, for only the ampullopetal current of the semicircular canal is active. In the left anterior vertical semicircular canal the conditions are reversed, for here only the ampullofugal current is effective. It produces, as is demanded by the theory, an upward and posterior movement of the eyes.

EDITOR'S ABSTRACT.

FORMATION OF CHOLESTEATOMA FOLLOWING POSTFETAL OCCLUSION OF THE AUDITORY MEATUS. W. DÖDERLEIN, Ztschr. f. Laryng., Rhin., Otol. (Teil 1: Folia oto-laryng.) **26**:34, 1935.

Döderlein describes the history of a boy, aged 5, who was brought to the hospital with the following anamnesis: At birth the child was normal. During the first year of life severe eczema developed on the right side of the face. This eczema healed in approximately two years. The mother then observed that the right auditory meatus was completely closed. Since the child occasionally complained of pains behind the ear, he was repeatedly under otologic treatment, but an operation was always avoided. Two days before hospitalization, pains developed in and behind the ear, and on the day of hospitalization the child had high fever. Examination disclosed no signs of deformity, but the right auditory meatus was completely closed, and behind the ear there was a slight edematous swelling that was extremely painful to pressure. The disorder was diagnosed as otitis media with closure of the external meatus, and surgical operation was resorted to at once. Following the usual incision behind the auricle, and after the skin and the periosteum had been lifted, dry white cholesteatomatous masses appeared. Not only the membranous but also the osseous auditory meatus was completely absent. The bone behind the ear, in a region the size of half a dollar, was paper-thin. Following the removal of this bone, a large cholesteatoma lay exposed. The tumor was completely removed with the raspatory, and after that a smooth-walled operative cavity was visible. The wall of this cavity was lined with the matrix of the cholesteatoma. The tympanic membrane was entirely absent, and the malleus was found entirely detached in the cholesteatomatous masses. The tumor consisted of dry epidermis scales. The postoperative course was uneventful, but it proved somewhat difficult to keep the cavity open, for there was a tendency to stenosis. Prolonged tamponade finally accomplished this, and now, one year after the operation, the cavity has about the width of a normal auditory meatus. The author enumerates the unusual aspects of this case, and in the conclusion he stresses that complete closure of the auditory meatus may be the result of deformity or may develop during the postfetal period as the result of inflammation, trauma or tumor. Deformity is caused by an inhibition of development, and with this type of closure there always exists a deformity of the auricle and there is no meatus behind the atresia. In the case of acquired occlusion, however, there is a meatus behind the occlusion and the auricle is not deformed. Surgical treatment of congenital atresia

is inadvisable not only because there is no prospect of an improvement of the hearing but also because of the danger of postoperative meningitis. Acquired atresia, however, should receive surgical treatment because it may lead to the formation of cholesteatoma.

EDITOR'S ABSTRACT.

ATYPICAL CHOLESTEATOMA. W. BERGER, Ztschr. f. Laryng., Rhin., Otol. (Teil 1: Folia oto-laryng.) **26**:39, 1935.

Berger thinks that the rarity of an atypical cholesteatomatous formation on the petrosa justifies the description of cases. He relates the history of a man, aged 38, in whom facial paralysis developed on the left side without apparent cause. The patient had no pains or attacks of vertigo. The author gives the anamnesis and the observations in the course of the examination and points out that in view of the middle ear baryecoia, the vestibular unresponsiveness and the facial paralysis in cases of suppuration of the recessus epitympanicus a typical secondary cholesteatoma that originated in the spaces of the middle ear could have been expected. However, roentgenoscopy according to Schüller and Mayer disclosed on both sides only absence of pneumatization and a wide communication between the antrums and the tympanic cavities; that is, it disclosed the defect of the recessus epitympanicus. The Stenvers exposure of the left pyramid was especially illuminating. A sharply outlined area of lesser density surrounded the upper vertical semicircular canal. The defect reached to the porus acusticus internus; that is, it lay primarily medially from the vestibule. A radical operation disclosed that there were no cholesteatomatous scales in the recessus epitympanicus or in the antrum. In view of the clinical and roentgenologic aspects the intervention was extended, and a cholesteatoma was found on the posterior surface of the pyramid. It was in close contact with the dura and reached to the porus acusticus internus. Its complete removal was followed by discharge of cerebrospinal fluid. Tamponade and bandage were applied, and after four days the bandage was changed. At this time there was no discharge fluid. After two weeks plastic repair of the auditory meatus was done, and the retro-auricular wound was closed. The after-treatment was the same as following the ordinary radical operation. The author points out that this case illustrates the importance of roentgenoscopy, particularly of the Stenvers exposure. It could not be definitely decided whether the cholesteatoma was primary or secondary.

EDITOR'S ABSTRACT.

AURAL COMPLICATIONS OF EPIDEMIC CEREBROSPINAL MENINGITIS. M. A. ZUCKERMANN, Vrach. delo **16**:706, 1933.

A study was made of the incidence and nature of aural complications in epidemic cerebrospinal meningitis during the epidemic in Charkow in 1931. A series of 230 cases was studied. The author's conclusions are: Acute otitis media occurred in 22.5 per cent of the cases, as compared with 50 per cent of the cases reported in the German literature. The incidence of acute otitis media as a complication of epidemic cerebrospinal meningitis was greatest before the age of 6 years, when it occurred in 78 per cent of the cases. The clinical course of early as well as of late otitis was usually uneventful, mastoiditis having occurred in only 0.8 per cent of the author's cases. Involvement of the vestibular apparatus occurred rather frequently in the author's series. Deafness, partial or complete, occurred in 3.8 per cent of the cases. As to the time of onset of the aural complications, 23 per cent occurred in the first week and 78 per cent during the second week of the disease or later. It had not been possible to isolate a meningococcus from the aural discharge, either by direct smear or by culture. Antimeningococcus serum did not seem to influence the frequency or the course of the aural complications.

BODER, Chicago. [AM. J. DIS. CHILD.]

Pharynx

CYSTS AND RETENTION ABSCESSES OF THE NASOPHARYNX. B. M. KULLY, J. Laryng. & Otol. **50**:317 (May) 1935.

According to Kully, there are comparatively few reports of cysts and retention abscesses in the literature on diseases of the nasopharynx. This scarcity may be due to failure in the comprehension and diagnosis of the condition rather than to rarity, as this report will show. The report covers eighty-eight cases, all of which have come under Kully's observation during the past six years. It is presented in the hope of emphasizing the importance of a more thorough examination of the nasopharynx. Cysts of the nasopharynx may be inflammatory, degenerative or developmental in origin. Kully discusses the pathologic observations and describes the symptoms. He emphasizes that twenty-two of the patients (25 per cent) presented no subjective symptoms referable to the nose or throat. The cyst or abscess was discovered on routine examination of the nasopharynx. Postnasal discharge was the most common symptom, being present in forty-eight patients. It was rarely profuse and in two instances had a foul taste and a foul odor. It was due to an overflow from the purulent cyst or to periodic rupture of the cyst followed by discharge of the contents. Frequently some of the discharge came from an associated hypertrophy of the mucous glands of the adenoid or from the mucous cells present in the membrane lining the crypts of the adenoid. Invariably present, secondary to the postnasal discharge, were chronic pharyngitis and chronic laryngotracheitis. Enlargement and tenderness of the posterior cervical glands were present in twenty-seven patients. These conditions were frequently associated with stiffness and rigidity of the muscles of the posterior cervical region. Occipital headaches were present in twelve patients. They were usually localized at or below the external occipital protuberance, in contradistinction to sphenoidal headaches, which are usually diffused over the occiput. In some instances the headache was relieved immediately on puncture of the cyst. Earache was present in only five of these patients. It was usually mild. In nine patients, there was a history of persistent fever of several months' duration. The temperature was never high, ranging from 99 to 101 F. The high point was usually below 100.5 F.

Direct inspection of the nasopharynx and palpation with the probe under direct vision are essentials in establishing the diagnosis of a retention cyst. Indirect inspection of the nasopharynx with the postnasal mirror gives an inadequate picture. Direct inspection of the nasopharynx is made with the aid of an instrument that retracts the palate and exposes the nasopharynx. The picture most frequently present is that of a smooth bulging in the vault of the nasopharynx, usually central but occasionally lateral. The mucosa covering it is smooth and, with few exceptions, presents an area of gray or yellow translucence at the point of greatest swelling.

In discussing the treatment Kully says that he treated four cysts with the actual cautery, destroying the anterior wall. Most of the others, however, he removed surgically. The technic was the same as that followed in the removal of adenoids.

EDITOR'S ABSTRACT.

ROENTGEN TREATMENT OF HYPERTROPHIED TONSILS AND OF RECURRING TONSILLITIS. A. GENTILI, Riv. di clin. pediat. **32**:769 (July) 1934.

Gentili reports on thirty-five children with enlarged tonsils with or without recurring tonsillitis who were treated with roentgen rays. Records were made as to the condition of the tonsils one month, six months and one year after the treatment. The application of roentgen rays caused no subjective or objective disturbance. In four cases good results, i. e., complete aplasia of the hypertrophied tonsils, were obtained; in five cases no effect was observed; in the other cases the shrinkage was only slight and frequently only temporary. Twelve of the thirty-five children required tonsillectomy subsequently.

Histologic examination of the excised tonsils revealed regression of the lymphatic tissue and proliferation of connective tissue. The roentgen rays caused greater reduction of infected than of noninfected hypertrophied tonsils.

HIGGINS, Boston. [AM. J. DIS. CHILD.]

ENUCLEATION OF TONSILS IN PATIENTS WHO FORMERLY HAD UNDERGONE TONSILLOTOMY. H. LIND, Ztschr. f. Laryng., Rhin., Otol. (Teil 1: Folia oto-laryng.) **26**:13, 1935.

Lind reports observations on thirty-two patients who had undergone tonsillotomy (some of them twice). He found that in none of the patients were the difficulties improved after tonsillotomy. On the contrary, the anginas became more severe, and as sequels there developed cardiac defects, articular symptoms and renal inflammations. In some patients tonsillotomy was followed by peritonsillar abscess. Inspection of the enucleated tonsils disclosed that after tonsillotomy the growth of the tonsils had not ceased, but that in some cases the intervention had induced proliferation. Histologic examination of ten specimens disclosed taut cicatrization and underneath the cicatrices tissues with infectious micro-organisms, which caused the tonsillogenic complications. Enucleation of the tonsils in the patients who at first had undergone only tonsillotomy produced satisfactory results. Consequently the author rejects tonsillotomy and advises complete enucleation in all cases in which operation on the tonsils is necessary. EDITOR'S ABSTRACT.

PATHOGENESIS AND THERAPY OF MIKULICZ' DISEASE. W. KINDLER, Ztschr. f. Laryng., Rhin., Otol. (Teil 1: Folia oto-laryng.) **26**:22, 1935.

After pointing out that different authors do not all apply the term Mikulicz' disease to the same symptomatology, Kindler states that if one eliminates cases which on the basis of present-day knowledge must be regarded as belonging to other groups of diseases (leukemia, lymphogranulomatosis and so on) there remain two groups of cases that present the symptoms characteristic of Mikulicz' disease: (1) cases in which besides the salivary and lacrimal glands, which show symmetrical swellings, no other organs seem to be involved and (2) cases in which in addition to these glands other glands are involved and in which the blood picture presents peculiar changes. Microscopic examination of the swellings of the salivary glands occasionally discloses granulation tissue like that which is characteristic of the malignant granuloma, and sometimes there are leukemia-like proliferations in the glandular tissue. A uniform pathogenesis is not known, and it is assumed that nonspecific as well as specific infections (syphilis, tuberculosis) may play a part in the development of Mikulicz' syndrome. On the other hand, the possibility of a more generalized disease of the glandular system is considered, and finally a disturbance of internal secretion is thought of. The treatment is, as a rule, purely symptomatic. In addition to medication with iodine and arsenic, roentgenotherapy has been recommended, and eventually surgical intervention is considered. The author describes the clinical history of a girl, aged 21, in whom Mikulicz' disease appeared in a rather severe, subacute form. The peculiar course of the disorder and the involvement of the thyroid and of the blood made an incretory disturbance seem probable. Because of this, medication with a thyroid preparation (produced from fresh hog's thyroid) was instituted and continued for three weeks. The patient received twice daily a tablet containing 0.3 Gm. of thyroid. After a few days the proliferations on the lacrimal and parotid glands began to recede, and after three weeks all lacrimal and salivary symptoms had disappeared. This case indicates that Mikulicz' syndrome may appear as a partial manifestation and as the leading symptom of a systemic disease. The incretory character of the disturbance in this case was indicated not only by the involvement of the thyroid but also by a severe genital hemorrhage and by the efficacy of the thyroid preparation after iodine and other therapeutic measures had been ineffective. EDITOR'S ABSTRACT.

Larynx

LARYNGEAL INTUBATION. AGUSTIN FERNANDEZ LAGOS, Rev. chilena de pediat. **5**:413 (Aug.) 1934.

Intubation is indicated in most cases of true croup. The outcome is uniformly favorable in the benign nontoxic form. The dangers increase with the toxicity of the disease and the length of time it has been present. Intubation requires more careful supervision by a trained and competent personnel than tracheotomy does. The author believes the optimal time for removal of the tube to be at from fifty-six to sixty hours. SCHLUTZ, Chicago. [AM. J. DIS. CHILD.]

ANATOMIC REFLECTED IMAGE OF MECHANISM OF FALSE VOCAL CORDS IN RELATION TO RECURRENT NERVE. A. RÉTHI, Monatschr. f. Ohrenh. **69**:414 (April) 1935.

This is the fourth of a series of reports in which Réthi describes his studies on the innervation of the larynx. In this paper he takes up the various positions of the vocal cords. In summarizing his observations he says that the internal branch of the superior laryngeal nerve is a mixed nerve; that is, it contains sensory and motor fibers. This is proved (1) by the anatomic aspects. This nerve sends motor fibers chiefly to the transverse arytenoid muscle but also to the thyro-arytenoid muscle, the lateral crico-arytenoid muscle and the posterior crico-arytenoid muscle. The external branch of the superior laryngeal nerve innervates in human subjects the cricothyroid muscle, but sends motor fibers also to the lateral crico-arytenoid muscle and to the thyro-arytenoid muscle. 2. If the internal branch of the superior laryngeal nerve is stimulated with a faradic current, a shifting of the glottis can be observed. 3. If this nerve is stimulated, and the transverse arytenoid muscle is watched meanwhile, muscular contractions can be observed. 4. The cutting of both recurrent (inferior laryngeal) nerves is followed during the process of swallowing (observations on dogs) by complete closure of the glottis. 5. Clinical observations prove that in case of paralysis of the recurrent nerve in human subjects slight twitching is observable on the arytenoid cartilages. The cricothyroid muscle is innervated only by the external branch of the superior laryngeal nerve. All the other small laryngeal muscles receive their motor innervation primarily from the recurrent nerve. However, in addition to the recurrent nerve, every muscle has also an auxiliary innervation that derives from the superior laryngeal nerve. The more perfect the laryngeal development, the more extensive is this auxiliary innervation; that is, in human subjects it reaches its highest form. If after the administration of a small amount of morphine and the establishment of a superficial ether anesthesia, the recurrent (inferior laryngeal) nerve is cut, the vocal cords assume the paramedian position near the midline. In paralysis of the recurrent nerve, there is no median position. If, in case of the paramedian position, the external branch of the superior laryngeal nerve is cut, and paralysis of the cricothyroid muscle is effected thereby, the vocal cord swings laterally from the paramedian position, and if then the internal branch is cut also, the complete intermediary position is assumed. If the branches of the recurrent nerve are cut after the administration of a large amount of morphine and in deep ether anesthesia, the intermediary position develops. Under these conditions, the vocal cord is free from all influences of muscular activity and is at rest and in equilibrium. If the internal or external branch of the superior laryngeal nerve has been cut previously, paralysis of the recurrent nerve is never followed by the paramedian position. The vocal cord assumes a position between the paramedian and the intermediary position; after the simultaneous cutting of the internal and external branches, the paralysis of the recurrent nerve is always followed by the intermediary position. Whereas the innervation by the recurrent nerve permits the fine play of the vocal cord, the auxiliary innervation may cause a shifting of the vocal cord into the paramedian position, keep it in this position and permit a playing of the muscles only during swallowing. If all nerves of the larynx are suddenly cut, there develops as the result of the intense stimulation of the muscles a strong

tonic muscular contraction which persists even after complete removal of the larynx. This manifestation is not the result of a direct nervous action but is the closure of the glottis as the result of a former stimulation of the muscles. Several days after the paralysis of the recurrent nerve closure of the glottis results from late stimulation of the muscles, for, because of the increased irritability of the muscles, closure of the glottis develops readily in response to slight traumatic influences.

EDITOR'S ABSTRACT.

Nose

SINUS DISEASE IN CHILDREN. REA ASHLEY, California & West. Med. **40**:156 (March) 1934.

Ashley considers the predisposing factors of sinus disease in children to be anatomic malformations, allergic tendencies, glandular dysfunction and poor general living conditions. The immediate etiologic factors are acute respiratory infections and the exanthems, especially pertussis and measles, contact with infected persons, swimming and diving. The symptoms are manifold and include local and general manifestations. The diagnosis depends on the evaluation of the symptoms, the presence of two cardinal signs, namely, postcervical lymphadenitis and lateral pharyngitis, and the roentgen observations. Treatment consists of general and local measures. The latter are divided into medical treatment with nasal packs of cotton saturated with a hydroscopic colloidal silver solution and conservative surgical treatment. The prognosis is good when treatment is undertaken early and carried out faithfully. Ashley emphasizes the necessity of close cooperation between the pediatrician, the allergist and the rhinologist in the solution of the problems of handling complicated cases.

MARSHALL, San Francisco. [AM. J. DIS. CHILD.]

TIP OF THE NOSE COMPLETELY SEVERED AND SUTURED THREE HOURS AFTER THE ACCIDENT. J. N. ROY, J. Laryng. & Otol. **50**:518 (July) 1935.

Roy describes the case of a boy, aged 7, who had sustained a transverse loss of tissue at the tip of the nose. The wound began at the right nasolabial fold and terminated at the left fold. At the latter point the cartilage of the nostril was exposed, which produced a slight notch. There was also a lesion of the lip and of the cheek on the left side. The patient was anesthetized, and at the same time light compression was made on the nose with a piece of ordinary gauze to stop the hemorrhage. Thirty minutes later the tip of the nose was found and brought to the hospital. It was carefully washed in tepid physiologic solution of sodium chloride and maintained in the same solution at a temperature of 98.2 F. The lip and the cheek were repaired three hours after the tip of the nose had been severed from the nasal pyramid. The wound was cleansed, and the tip of the nose was carefully coapted and sutured with silk by means of small conjunctival needles. A light dressing was applied to the left nostril and to the exterior. In order to stabilize the tip of the nose and to increase its vitality a copper splint was applied. The splint was retained by bands of adhesive tape applied transversely to the nasal appendix. The postoperative sequels were normal, and the left nostril was dressed forty-eight hours after the operation. The dressing was renewed daily. Five days later the external dressing was changed. At that time a dry sanguineous layer appeared over all the periphery of the sutured tip of the nose. This presented at its center a reddish color which gave hope for its vitality. One year after the operation the recovery on the right side is perfect. Since the cartilage on the left side was exposed at the time of the accident, the nutrition of the cutaneous flap has been poor. Also, a loss of substance at the inferior part and a little depression in the nasolabial fold are the result. The scars of the lip and cheek are soft and hardly perceptible. This report proves that it is possible to replace a fragment of skin separated from the organism for a few hours and to obtain an excellent result.

EDITOR'S ABSTRACT.

Miscellaneous

THE STORY OF TRACHEOTOMY. E. W. GOODALL, Brit. J. Child. Dis. **31**:167 (July-Sept.) 1934.

This, the first instalment of a historical review of tracheotomy, treats of the subject from the time of Fabricius of Aquapendente, when the operation was known as "the scandal of surgery," up to the second quarter of the nineteenth century.

LANGMANN, New York. [AM. J. DIS. CHILD.]

RELATIONS BETWEEN DIABETES MELLITUS AND CONDITIONS IN THE UPPER AIR PASSAGES. B. MAYER, Monatschr. f. Ohrenh. **69**:397 (April); 564 (May) 1935.

Mayer shows that the connections between diabetes mellitus and disorders of the upper respiratory tract are extremely manifold. The relationship between diabetes mellitus and conditions in the nose is comparatively slight. Wounds of the nose heal more slowly during diabetes; there is a rather high incidence of nosebleed, and in rare cases there exists gangrene of the septum. Some diabetic patients have typical pharyngitis and laryngitis sicca, and furunculosis and phlegmon of the larynx are likewise observed in diabetic patients. These disorders respond to antidiabetic treatment. A relationship between diabetes mellitus and disease of the tonsils has not been demonstrated as yet, but the salivary glands frequently show sclerotic changes which, however, seem to be of only slight importance. Excessive salivation is found in comparatively many cases of diabetes mellitus, and the saliva usually has an acid reaction because of the presence of lactic acid. Formerly it was assumed that the changes in the saliva were the chief cause of the disorders of the oral cavity in diabetes mellitus. Today it can be conceded only that the acid reaction of the saliva is increased by the lactic acid that is present. The surprisingly great incidence of dental caries cannot be explained by the elimination of sugar in the saliva, because the demonstration of sugar in the saliva is possible only in rare cases of diabetes mellitus. Many authors consider paradentosis as an early symptom of diabetes. Although this assumption cannot be accepted completely, one cannot deny that pyorrheal paradentosis is a characteristic accompaniment of diabetes mellitus and that its chronicity is largely caused by the the metabolic disorder. Formation of tartar on the teeth is also especially pronounced in diabetic patients. The gums are frequently loose, and there often is gingivitis with a tendency to bleeding or to ulceration. The sense of taste is often dulled in diabetic patients, and many experience constantly a sweetish taste. The majority of diabetic patients show typical changes of the tongue. The surface appears dry and lacquered and has a fissured structure. Occasionally the tongue is coated, and paresthesias of the tongue are comparatively frequent. Tuberculosis of the tongue and of the respiratory passages progresses rather rapidly in diabetic patients.

EDITOR'S ABSTRACT.

HARMONY OF PHYSIOLOGIC AND ESTHETIC NORM IN SPEECH. ELSIE FOGERTY, Monatschr. f. Ohrenh. **69**:602 (May) 1935.

Fogerty points out that just as it is impossible to produce normal speaking when certain organs of the body are anatomically defective, the higher forms of vocal expression are also to a considerable extent dependent on adequacy in the normal activity and in the physiologic properties of the human organism. The physiologic norm is of fundamental importance for the schooling and further development of good speaking. Physiologic and esthetic considerations must exert a guiding influence on phonetic classifications. She further gives her attention to other forms of vocal expression that contain elements in addition to those of the code of linguistic expression, namely, singing, poetic recitation, drama and oratory. After giving definitions of these four forms of expression, she shows that singing demands vocal purity and melodic lines; recitation requires complete

rhythmic action in space, force and time; drama demands character presentation together with audibility and significance, and oratory requires volume and an easy manner of voice expression, which on the one hand charms the audience and on the other leaves the mind of the orator free to be concerned with nothing but the content of his speech. The esthetic norm of vocal expression involves physiologic and rhythmic factors. The correct physiologic process in the formation of sound requires an exact synchronization between the expiration of air and the adduction of the vocal cords. The author describes the defects that result from a too sharp or a too slow expiration and points out that if a tone is correctly timed it can be produced without much effort. Further she discusses the resonance of vocal expression. In remarks about the treatment of defects of speech, she stresses that the therapeutic methods must always take account of the normal physiologic functions, for, unless this is done, they will fail to accomplish their aim.

AUTHOR'S ABSTRACT.

INDIVIDUAL PSYCHOLOGIC STUDIES ON STUTTERERS. ALICE FRIEDMANN, Monatschr. f. Ohrenh. **69**:608 (May) 1935.

The observations described by Friedmann are based on studies which she made of 130 stutterers in a Vienna clinic. Analysis of the personalities of stutterers according to the method of individual psychology reveals difficulties in their contacts with life. Their complaints resemble greatly those of other neurotic persons. Such patients are characterized by low self-esteem, the feeling of exclusion, of being disregarded, of being unable to make contacts with others, of being deprived of their personal expression, of being different from the others. The essential characteristic of their psychic make-up is a depressive feeling of inferiority. Factors are cited that play a part in the development of stuttering in children; among other things, hardness of hearing in the parents, loquaciousness of the parents or an overemphasis on faultless speaking may exacerbate the feeling of inadequacy in the child. Stutterers usually exhibit a tendency to concealment. School children who stutter often show a preference for activities that do not require speaking (drawing, gymnastics). Although many stutterers are characterized by great reticence, there are some who have an overbearing behavior. On closer psychologic investigation, the loquacious and intrusive stutterers are not always courageous and satisfied persons. A study of the dreams of stutterers reveals that the anxious, pessimistic attitude toward life which usually characterizes these persons is also expressed in their dreams.

EDITOR'S ABSTRACT.

REMOVAL OF FOREIGN BODIES FROM THE LOWER AIR PASSAGES WITH THE AID OF THE HASLINGER BRONCHOSCOPE. P. G. GERLINGS, Nederl. tijdschr. v. geneesk. **78**:3546 (Aug. 4) 1934.

Gerlings describes the procedure of Haslinger and discusses the advantages of this method over others, especially the method of Brünings, which was used formerly. He describes the excellent results obtained with the bronchoscope used by Haslinger in twenty-four cases of foreign bodies in the lower air passages; with one exception all the cases were those of children under 3 years of age.

VAN CREVELD, Amsterdam, The Netherlands. [AM. J. DIS. CHILD.]

Book Reviews

Das supra-vestibuläre System bei den Tieren und beim Menschen, mit besonderer Berücksichtigung der Klinik der Blicklähmungen, der sogen. Stirnhirnataxie, der Zwangsstellungen under der Zwangsbewegungen. By Dr. L. J. J. Muskens. Price, 25 marks. Pp. 557, with 48 illustrations and 8 tables. Amsterdam: N. V. Noord-Hollandsche Uitgevers Maatschappij, 1934.

This is in many ways an encyclopedic production. It is remarkable not only for its scope but for the fact that Muskens has done an almost superhuman piece of work. It represents, one would imagine, almost a lifetime of research in the field of the anatomy and pathology of the vestibular apparatus and the central nervous system. The book is one which does not lend itself well to review, for to describe the contents adequately would require a small volume in itself. Every phase of the supravestibular system in man and certain animals is discussed, the result of experimental work detailed and the data still further elucidated by means of eight tables and forty-eight illustrations. This work is not adapted for reading by the average otologist, but is a stupendous and marvelous reference book for those otologists and neurologists who are interested in the details of the vestibular mechanism and in experimental work and the investigation of the problems connected with this subject. It is a monument to the author and should prove of inestimable value to all who deal with the scientific aspect of this subject. The book is presented in splendid form, with the subjects arranged in systematic and logical order, and is most authoritative and valuable.

Angines lympho-monocytaires, Agranulocytoses, leucémies-leucopéniques. By Professeur Jean Sabrazès, Médecin des Hôpitaux de Bordeaux, Associé national de l'Académie de Médecine, and René Saric, Interne des Hôpitaux de Bordeaux. Paper. Price, 40 francs. Pp. 363, with 18 illustrations. Paris: Masson & Cie, 1935.

This publication is concerned essentially with the differential diagnosis of mononucleosis, agranulocytosis and acute leukopenic leukemia. There are three chapters, each dealing with one of the subjects designated in the title. An extensive bibliography is appended to each chapter, embracing all the literature inclusive of January 1935. Each chapter presents the same general outline—a brief historical description, a detailed hemotologic and pathologic study and a well outlined diagnosis. The etiology and treatment are handled more or less by hiding behind the literary references, which is rather disappointing to the clinician, who searches for definite therapy. Some of the reports of cases may be justly questioned as to diagnosis, despite the convincing results of pathologic examination.

If the authors could have given a more definite program of treatment, this publication would prove invaluable at this time. Regardless of this fact, it is a commendable contribution because of the discussion of hemotology and pathology. Any one conversant with the language will derive a vast amount of information from this work.

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